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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

OCTOBER 7.

Diesel Engine Users' Association:—Meeting at Caxton Hall, Westminster, S.W.1. Paper, "Some Fuel Experiments in a Mechanical Injection Oil Engine," by Mr. E. L. Bass.

OCTOBER 11.

Institute of Marine Engineers:—Ordinary meeting. Paper by A. F. C. Timpson, M.B.E., on "A New Form of Insulating Materials for High Temperatures."

OCTOBER 12.

Institute of Metals (Swansea Local Section):—Chairman's address by Capt. L. Taverner, A.R.S.M., D.I.C.

OCTOBER 13.

Institute of Metals (London Local Section):—Chairman's address by Mr. A. H. Mundey: "Works' Economics."

OCTOBER 14.

Institute of Metals (Sheffield Local Section):—Chairman's address by J. H. G. Monypenny on "Science and Industry."

OCTOBER 8.

Institute of British Foundrymen.

Lancashire Branch (Junior Section):—Opening meeting at Manchester. Chairman's address by T. Makemson on "The Work of the Foundryman in relation to the Drawing Office."

The Change Over.

A quarter of a century ago the then Editor of THE FOUNDRY TRADE JOURNAL, in his first leading article, set forth the aims and objects he hoped to achieve. He wrote:—"The foundry trade has, up to the present, been sadly neglected in the way of literature of a trade nature, devoted specially to its advancement and interest; existing trade journals only touch very lightly on foundry practices.

"Foundrymen in general have long felt the want of a good medium for the exchange of ideas and experiences, and the illustration of the improved methods that from time to time are placed upon the market. Without this interchange it is impossible to estimate the advantage to be gained by adopting advanced ideas that have already been tested and found profitable.

"There is no doubt that in this country the foundry has been greatly neglected, and allowed to remain in almost the same state for nearly a century. It is a well-known fact that in some foundries no improvement has been made upon the tools that were in use fifty years ago, and, in some cases, are still in use to-day, restricting the possible output to a very great extent, and making it very difficult for English firms to compete on terms with those of other countries.

"Our journal is instituted to illustrate and advise foundry-masters of the best means of facilitating and improving the manufacture of castings of all descriptions.

"It is our main object to bring before our readers those articles of machinery, etc., that have been adopted in this and other countries, to the advantage both commercially and financially of the trade.

"Unless some radical improvements are introduced, and methods of production brought more into line with those of other countries, England will find herself gradually driven out of the markets which for many years she has regarded as entirely her own.

"We hope our readers will support us in our endeavour to ameliorate and enhance the well-being of the foundry, raising it in importance and to the level hitherto enjoyed so exclusively by the machine shops.

"We shall endeavour to run this journal on the highest plane of trade journalism, employing the best writers that can be obtained, and publishing their ideas in a succinct and readable manner. We wish to make our journal a book of ready reference to our readers. Our aim is *utility*—to become the necessity of the greatest number; not to be a magazine that only appeals to a few."

We regret to have to record that in spite of the efforts of THE FOUNDRY TRADE JOURNAL and the scientific associations which grew from its publication, there still exist foundries of the type where "no improvement has been made upon the tools that were in use fifty years ago," but they are rapidly becoming rarer. We agree with Mr. Wilson, in his Presidential Address to the Middlesbrough Branch of the Institute of British Foundrymen, that a legacy of neglected costing in foundries is the cause of much price cutting, a disease which stunts progress owing to the non-existence of means to provide equipment of a modern character. We would like our message from this, the first number of the new enlarged journal, to be a plea for co-operation amongst competing foundrymen, so that they may primarily improve the financial conditions of their industry, with the ultimate object of lowering prices by means of increased efficiency for the benefit of their customers. How urgently this reform is needed is shown by the offers which are received from time to time from buyers for an "unbalanced" production, by which we mean that the orders are of such dimensions that the major portion of the firm's output is going to one customer. Loss of this one—or may be two—customers means the closing of the foundry, at least temporarily, until other customers can be found. Thus a well-managed, profitably-exploited foundry is at the mercy of the blandishments of a salesman attached to a firm who may price-cut through ignorance of costing.

The mechanical equipment of foundries, too, has made great strides, and the oft-repeated dictum that the sole means of conveying sand is by an overhead crane and a grab-bucket has become obsolete, as conveyors have been made to work and to work economically. This revered adage about conveyors was due, no doubt, to the glib tongue of a well-known and respected member of the industry, who every time the question was raised, closed the discussion by saying that he knew of an installation which had been thrown out and which could be had at scrap-iron prices. Thus is progress arrested! Just because some foundryman has either chosen a wrong type or failed in some other direction, a system which even casual thought shows to be basically correct, is temporary placed out of the realms of practical politics. We believe a research into the history of moulding machines would disclose parallel conditions. Mr. Wilson's reference to the conversion of a foundry into an engineering exhibition is added evidence of disaster resulting from incompetence in buying.

Undoubtedly the greatest and surest progress to be recorded is that of the metallurgy of the alloys which the founder handles. No longer is sulphur the *alpha* and *omega* of metal defects. No difficulty is now experienced in finding a foreman capable of mixing to analysis. The foundry owner now knows how to utilise a metallurgist, though he hesitates to employ one. The British Cast Iron Research Association, together with its parent organisation, the Institute of British Foundrymen, create in the minds of the buyers, both home and overseas, a confidence in the worth of British castings which is probably the most effective publicity campaign for the industry which could be devised. Their work gives to the consumer the assurance that British castings are the product of an erudite industry.

We are proud of the fact that THE FOUNDRY TRADE JOURNAL has done its part in bringing these

bodies into existence, and in fostering their welfare. The progress shown by The Foundry Trade Journal convinces us that beyond enlargement there is no need for us to modify our policy in any way, beyond utilising the extra space it gives us to helping sections of the industry which demand specialised information not universally interesting. For instance, the casting of manganese steel would interest from a practical point of view roughly 0.125 per cent. of our readers, as there are only a handful of firms specialising in this branch of the steel industry.

May we take this opportunity of thanking the foundry and allied trades and their suppliers for the wonderful and consistent support they have accorded us during the last 25 years.

The High Lights of the French Exhibition and Congress.

By Our Paris Correspondent.

IMPROVEMENTS IN CAST IRON.

Now that the Paris Foundry Exhibition and Congress is over it seems desirable to ask just what it has shown, and what is likely to be retained in the minds of the visitors.

It has been thought interesting to print our French Correspondent's Report without materiel modification as it throws light on the French viewpoint of modern foundry developments, which are not always comparable with British.—Editor.

Primarily, from the point of view of improving the quality of iron and steel castings, it can be stated that manganese, nickel and chromium additions are now quite normal practice. Likewise the quality of grey iron can be modified by controlling its structure. German metallurgists, who, in recent years, have confined their attention to the control of the metallic constituents so as to produce an all-pearlitic structure, are now turning their attention to the graphite and talk of the formation of eutectic graphite by rapid solidification.[1] However, there are conditions influencing the graphitic structure of cast iron which are only controlled with great difficulty, and which constitute what has been called "Inherent Properties."[2] The recognition of these inherent properties is likely to change once again the classification of pig-irons, which recently have tended more and more towards the basis of chemical analysis.

Testing Cast Iron.

The question of testing cast iron has been of paramount interest in foundry circles for the last few years. It is now definitely established that tensile testing ought to be abolished and replaced by shearing tests,[3] and that shock tests are spoilt by their liability to error. Shearing tests of the punching variety instead of plain shear, as recommended by some authorities, apparently increase the liability to error. The difficulty of obtaining test pieces which will give reliable and consistent results still remains. The choice of the diameter of balls for use with the hardness test is still controversial, but it is established that no good can be expected from reducing the diameter of the impression, because the larger the diameter, the less the error. As to the transverse test, it still remains for the various countries to agree as to the type of bar to adopt; the British, American and German bars, and the French Frémont test have each their supporters. During the discussion of the Papers, it was once again stated that heat treatment of cast iron was without physico-chemical influence, and was only really useful from the point of softening, and again should the temperatures to be adopted be arbitrary, they should be standardised by some means such as the Chevenard dilatometer.

Melting Problems.

It seems certain that modern opinion is trending little by little in favour of the electric furnace. The duplex process,[4] using a combination of the cupola and the electric furnace, tried out in Italy, is worthy of close study. The electric melting of copper alloys is likewise a serious commercial proposition.[5] As to the actual furnaces, the rotary-arc furnace seems to be a proposition with a future.[6]

Moulding Practice.

Moulding methods remain virtually unchanged. Constant effort is being made to render them still more automatic by limiting the moulder's movements to a minimum, as is clearly seen in the sand slingers,[7] and hinged turnover machines.[8]

It was a noticeable feature that, with some brilliant exceptions, the use of compressed air has become almost general. Continuous moulding has been adopted by numerous foundries, and a continuous machine[9] designed for the quantity production of shallow-draft castings is from this particular aspect extremely interesting.

Constitution and Preparation of Sand.

After testing methods, no subject is more important to grey-iron founders than the constitution and preparation of sand. The Italians have shown how sands can be synthetically prepared.[10] Automatic sand preparation is characterised by the deep grip it has taken on the foundry world. At the moment throwers or combers are all the rage.

Sand Blasting.

Cleaning castings by sand blasting has also made distinct progress. For instance, designers have eliminated models which were liable to extreme wear with its constant replacement of worn out members. There has also been a suppression of the plain circular movement in favour of elliptical or waving motion of the actual jet.

Non-Ferrous Foundry Work.

In non-ferrous foundry practice it can be truthfully stated that, as in the case of grey iron, there has been general tendency to replace simple alloys by special ones, such as aluminium bronze, bronze and brass with nickel or manganese additions.[11] The study of these alloys has made great strides thanks to micrography, which can, in this case, usefully replace microscopy,[12] for it provides extremely useful information as to the texture of the different sections of the casting. Finally, the considerable progress made in the preparation of light alloys must be emphasised, whilst knowledge of the melting of these alloys has been definitely advanced.[13]

The wonderful results achieved with Alpax give promise to an extension of its application from the aviation and automobile industries to railway[14] and chemical work.

[1] "Le Graphite Eutectique de la Fonte Grise," by Dr. Schüz.
[2] "Sur l'Hérédité des Fontes," by André Levi.
[3] "Contribution à la question des Essais de Fonte," by Prof. Pishek; "Method Simple et Rapid pour le Control des Propriétés Mécanique en Fonte Moule," by M. Girardet; and "Quelques Methods d'Essai et Propriétés Diverses des Fontes Grises," by Herman & Henquin.
[4] "Les Applications du Four Electrique en Fonderie de Fonte," by Prof. Lemoine.
[5] "La Fusion Electrique des Alliages de Cuivre," by Prof. Lemoine.
[6] Fours à Arc Tournant, by the Secomet Company.
[7] Beardsley-Piper & Badische-Machinen-Fabrik.
[8] Jar Ram-Turnover, by Gutmann.
[9] Continuous moulding machine by Rosieres Bachon.
[10] "Essais et Propriétés des Sables de Fonderie," by Prof. Serovich.
[11] "Quelques Propriétés des Laitons Speciaux au Nickel Manganésés," by Le Thomas.
[12] "Étude de la Macrostructure des Metaux et Alliages Non-ferreux," by A. Portevin.
[13] "Influence de l'Alumine sur la Coulée de l'Aluminium," by F. Renaud.
[14] Doors and diverse castings for railway carriages—Montupet & Forges de Crans.

The Institution of Chemical Engineers is opening its session for 1927-8 with an important lecture, to be delivered by Sir William Bragg, K.B.E., F.R.S. The subject will be "Crystallisation," and the meeting will be held in the Institution of Civil Engineers, Westminster, on Friday, October 28, 1927, the President, Sir Alexander Gibb, taking the chair at 6.30 p.m. There will be no charge for admission, but tickets (to admit two) can be obtained on application to the Hon. Secretary, Institution of Chemical Engineers, Abbey House, Westminster.

Random Shots.

Well, September, with its formidable list of meetings and conferences, has gone, and we all seem to be alive still. Maybe, the more the merrier, and in this matter of autumn meetings one cannot help suspecting that the fewer, the better results. Many of us went to Paris, more of us went to the Shipping Exhibition, some to the Institute of Metals meeting, and others to the Iron and Steel Institute, but our vast activities seem to have received singularly little echo from the general public. Everyone was, as usual, highly entertained by the British Association, and the visions of white-haired eccentrics that it still conjures up; they were suitably interested by carefully-selected reports of the Industrial Welfare Society's conference at Oxford; and they were even given pictures from Olympia, which in some mysterious way managed to introduce a pair of attractive young ladies' silk stockings and all complete, into that otherwise serious-minded background of metal and machinery. Perhaps the public is to be envied; at least its mind is made up, for it is in this matter, while to us is left the long, heart-searching business of determining the relative values and importance of this and that, the merits of rival claims, the worth of novel theories.

* * *

And out of the fullness of this last month's experience may be put in a humble plea that other places than our big industrial cities might possibly be pleasanter for summer conferences—always supposing that summer will ever again be a factor to consider at all. Were we to follow the example of many technical conventions in America—an example as yet followed in this country only by trade unions and friendly societies—we should certainly bring joy to the hearts of those seaside and country hotel-keepers who complain so bitterly of the expense of keeping up their establishments for the passing patronage of week-enders. There might conceivably be a rather less elaborate civic welcome, but assuredly there would be other advantages to off-set that.

* * *

Some comment was aroused recently by the estate of £8,000 left by a deceased ironfounder, but an explanation was rapidly forthcoming. The gentleman had lived a most exemplary life—had invariably paid the strictest attention to business, had never attended a race meeting nor played a round of golf, had been a non-smoker and a strict teetotaller. He had always avoided the fair sex, and he had never married. A short time before his demise an avuncular relative conveniently died in Australia, leaving him an unexpected legacy of £10,000, and so the mystery was solved.

* * *

The old argument as to the rival merits of casting and forging for steel is likely to be given renewed life by a recent success for the former method. William Beardmore and Company have just produced a finished cast-steel chain for the Admiralty which meets all requirements. It has been tested with a proof load of 204 tons, this being the accepted breaking load for wrought-iron chains, and has proved quite free from defect at several points in the links which have been sawn.

* * *

In connection with our remark of last week on the Kearney Tube Railway and the growing scope that our big cities are offering for such work, it is interesting to observe that the municipal authorities of Tokio have decided to instal an underground railway at an estimated cost of £1,650,000. So it becomes apparent that the traffic problem which we all lament so sorely in these islands is by no means an Anglo-Saxon or even a European monopoly.

Marksman.

Aluminium from Clay.—The Clay Reduction Company, of Chicago, has acquired of Segland Svendsen, formerly of Sarpsborg, Norway, his method for the manufacture of alumina. This method is particularly adapted for siliceous raw materials, such as common clay and bauxite of a high silica content, and is said to bring a greater yield of alumina than methods now in use. It is stated also that a pure silica of very high porosity is obtained as a by-product.

The Use of Silica Gel as a Medium for Drying Blast.*

By Edwin H. Lewis, M.A. (Wishaw).

The varying amount of moisture in the atmosphere and its effect on blast-furnace practice has for a long time been of interest to ironmasters. It is 128 years since the first essay read to the "Friendly Association of Ironmasters" by the first President (Mr. Joseph Dawson), dealt with this subject. Similarly, at the inaugural meeting of the Iron and Steel Institute, the Duke of Devonshire referred to the question as one of importance.

The importance of these figures will be realised more readily if it is borne in mind that each 0.5 grain per cub. ft. in the blast represents about 10 lbs. of water per ton of pig-iron made. In order to trace the result of monthly variations on the output of pig-iron, some figures were taken out, and showed in the case of one furnace 1.5 per cent., and in the case of another furnace 3.0 per cent., difference between the four summer and the four winter months.* As a further test the average ratio $\frac{\text{ore}}{\text{coal}}$ was calculated for ten pre-war years for all the furnaces in blast, and is reported in Table I.

Table I.—*Average Ratio of Ore to Coal in Ten Pre-war Years.*

	Ore/Coal Ratio.		Grains per cub. ft.	
December ..	1.0538		2.6	
January ..	1.0451	1.0448	2.6	2.6
February ..	1.0356		2.6	
March	1.0428		2.5	
April	1.0213	1.0301	3.0	3.3
May	1.0390		3.7	
June	1.0255		4.2	
July	0.9955	1.0138	4.8	4.5
August ..	1.0109		4.9	
September ..	1.0233		4.2	
October ..	1.0390	1.0289	3.6	3.3
November ..	1.0188		2.9	

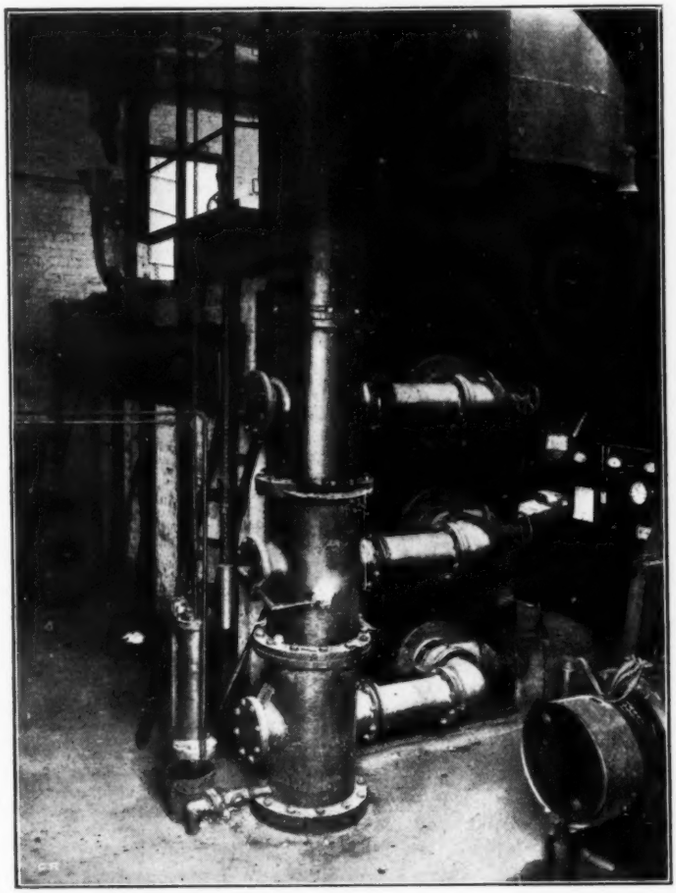


Fig. 1.—Combustion Furnace and Gas Burners for Blast-Furnace Gas.

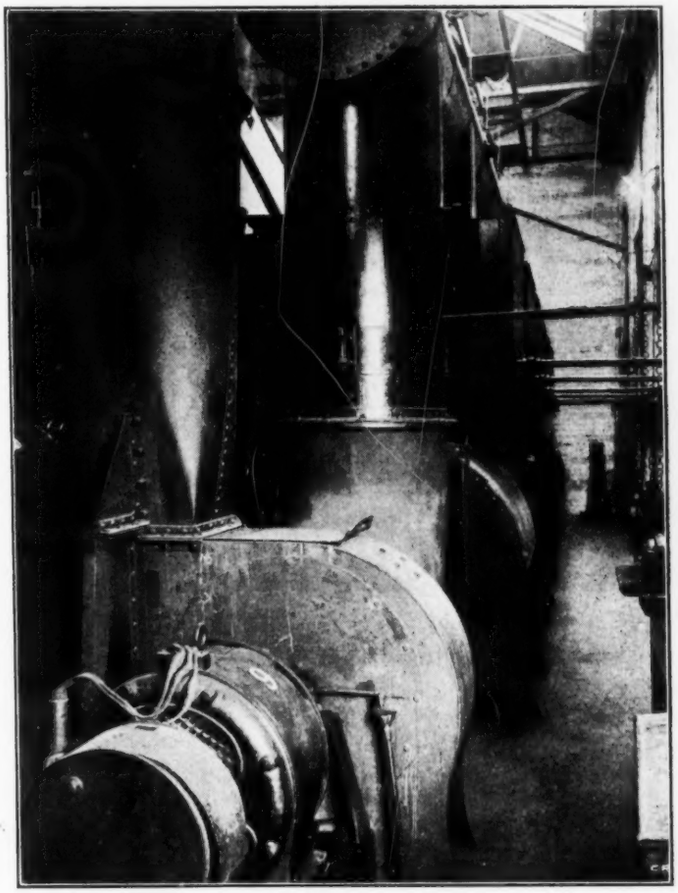


Fig. 2.—Motor and Fan Drawing Activating Gases through Adsorbers during Period of Activation. Dry-Air Duct shown behind Fan.

Silica-Gel Plant at the Wishaw Works of the Glasgow Iron & Steel Company, Limited.

Figures showing the hourly variation of atmospheric moisture were given by Gayley in his classic Paper before the Institute in 1904.† No complete records over a long period of the moisture at Wishaw have been taken. Figures, however, taken in the West of Scotland confirm the relative variations, although in the Scottish climate the maximum moisture does not reach so high a point as that observed by Gayley. Half-hourly readings at Wishaw taken from the middle of April show the following maxima and minima, in grains per cub. ft. of atmosphere:—

1927.	Maxima.	Minima.
April	4.70 (18th)	1.11 (27th)
May	5.88 (8th)	1.47 (10th)
June	5.57 (16th)	1.33 (12th)
July	6.51 (10th and 30th)	3.62 (16th)

In Scottish practice the weight of air used per ton of pig-iron is about 10 cwts. more than the total weight of all other materials charged into the furnace. So that if much care is taken in selecting, sizing, and conditioning the other materials, it seems only logical to get the air also into the best possible state.

Again, there are so many variable factors in blast-furnace operation, that it is desirable, if possible, to pin down one of the variables. The desirability of constant blast moisture is generally agreed, if such a result can be procured at a reasonable initial and running cost. Many attempts have been made, and processes suggested, to obtain such a constant blast, either by freezing or by absorption of the moisture chemically with calcium chloride, sulphuric acid, etc. There has been much discussion concerning the merits of these processes, and the criticisms can be summarised under three heads:—(1) That the absorption methods have proved impracticable. (2) That freezing is too expensive in maintenance and running costs in comparison with the results obtained. (3) That in all cases the money spent would have been better spent in improving other conditions, such as increasing the blast temperature.

At Wishaw the blast temperature is from 1,450 to 1,500 deg. Fah. (788 to 816 deg. C.), and it is not possible to raise it without danger to the refractories in the stoves. Although the possible savings from the use of dry blast are not so great at such a blast temperature, it still seemed possible to improve the efficiency of the furnaces if dry blast could be obtained at a moderate cost.

A few years ago the use of silica gel was suggested. This material, which is now made in large quantities and of uniform quality, has

* A Paper read before the Autumn Meeting of the Iron and Steel Institute.

† "Journal of the Iron and Steel Institute," 1904, No. II, pp. 274-300.

* See "Industrial Fatigue Research Board Report," No. 5, 1920, p. 17.

wonderful powers of adsorbing water. Its properties were described by Mr. C. B. Miller before the American Institute of Chemical Engineers in Montreal, on June 28, 1920. The main features from the blast-furnace point of view are that at atmospheric temperature it can adsorb up to at least 20 per cent. of its weight of water from the air with an efficiency of 99/100 per cent., and that by raising the temperature this water can be driven off, leaving the reactivated gel ready for another cycle. It is not advisable to reduce the water content below about 5 per cent. In practice it is desirable to have about 1 lb. of gel for each cub. ft. of air to be treated per min.

A plant to treat 35,000 cub. ft. per min. has been erected at the Wishaw Works of The Glasgow Iron and Steel Company, Limited, and has been in operation since April 13 of this year. It contains six adsorber units. Each unit consists of a large steel box, in which are placed trays containing the gel in granular form. The bottoms of the trays are perforated, and the latter are so arranged in the box that the air passes through them in parallel. At one end of each box are valves communicating with the atmosphere or with the activating gases. At the other end are similar valves which allow either the air to pass to the blower, or the gases and water vapour to pass to a small exhaust fan which is used for activating. Five units are normally used for adsorption while the other one is being activated.

At the atmospheric inlet "Visco" filters are placed to remove the dust which is always found in the atmosphere of an industrial district, and which, if pulled into the gel beds, would tend to clog them and increase the suction (1½-in. to 2-in. water-gauge) necessary to draw the air through. The heat for activation is provided by the combustion of blast-furnace gas, which has been cleaned in the process of recovering the by-products from the raw coal used in the furnaces. The gas is burnt in a small combustion chamber, and an excess of air is admitted to reduce the activating gases to about 640 deg. Fah. (338 deg. C.). All the air used for combustion and dilution is also passed through "Visco" filters. The normal period for the activation of one unit is about 1½ hrs. During the latter part of this time the gas is turned off and air only is drawn through to cool down the gel and bring it to an efficient condition for adsorption. The valves at the two ends of the boxes are coupled together so that the "reversing" of a unit is done in a single operation. The gas is of about 135 B.T.U. per cub. ft. and the amount required represents the equivalent of about 7 tons of coal per day.

Between the dehydrating plant and the blower there is an adjustable inlet for atmospheric air, which is used for diluting the dried air up to the moisture figure aimed at. If this were not used it would be difficult to maintain a constant moisture. In cold weather the plant has given a degree of dryness far below anything achieved by Gayley.

It is not easy to give absolutely definite results of the use of dry blast under Scottish conditions. With a number of small furnaces blown at constant pressure from a common main, and making different qualities of iron, many other variables come into the picture. Then again, the true blast-furnace gas is so diluted with the "coke-oven" gas formed in the upper part of the furnace that the effect on the CO/CO_2 ratio is difficult to observe. In 1925 the Wishaw Works produced the largest amount of iron recorded in their history, and the fuel consumption was the lowest for many years. It is the latest unbroken year, so that in Table II it has been taken as a standard. In May, June, and July of this year (1927) the dehydrating plant has been in continuous operation, although, being the first of its kind ever built, it is still in the stage of minor adjustments which is common to all new plant.

The figures in Table II require some explanation.

Moisture in Blast and Atmosphere.—The figure for 1925 is taken from the average of the district. The figures for 1927 are the averages of half-hourly spot readings taken at Wishaw.

Output.—Since 1925 some slight changes have been made in the lines of three out of the five furnaces now in blast. An analysis of the individual furnace returns shows that not less than 7½ per cent. of the increase is apparently due to drier blast.

Total Carbon Used.—These figures are taken from the quantities of coal and coke used, and their analyses.

Carbon Burnt at Tuyeres.—This is obtained from the total carbon used by deducting 350 lbs. per ton of iron as an allowance for solution loss and direct reduction. The actual quantity of 350 lbs. is taken from results tabulated by Mr. E. C. Evans from a large number of furnaces using similar ores.

Available Hearth Heat.—Wishaw conditions have been assumed, namely, critical temperature 3,000 deg. Fah. (1,649 deg. C.) and blast temperature 1,450 deg. Fah. (788 deg. C.), for the purpose of applying Johnson's theory. The balance of heat available per lb. of carbon burnt is shown below:—

Grains per cub. ft. of water in blast.	B.T.U. available per lb. of carbon burnt.
Nil	1,788
1	1,729
2	1,671
3	1,613
4	1,557
5	1,501
6	1,446

The correctness of Johnson's theory is a matter of controversy; certainly his figures seem to agree closely with the actual savings obtained. It will be interesting to see whether future results show such close approximation to his theory.

A point in favour of constant moisture in the blast is the more regular quality of iron produced. This is the experience at Wishaw, but cannot easily be put into figures. The fuel saving in the case of furnaces on special hematite must give a small but important reduction in the total phosphorus and sulphur charged into the furnace.

The costs of running such a plant are small. The only moving parts are the hand-operated valves and the motor-driven activating fan, which takes 20 h.p. The maintenance costs should also be low. The financial saving requires to be worked out for each individual case according to local conditions. The amount of fuel saved will depend largely on the blast temperature and the average moisture in the atmosphere; its value on the cost of fuel and the cost of limestone required to flux the ash in the fuel. The further saving in cost per ton will depend on many factors, such as the proportion of the wages cost which represents

Fig. 3.—Filters Admitting Atmospheric Air to the Combustion Furnace. Dust Separator on Right (Top).

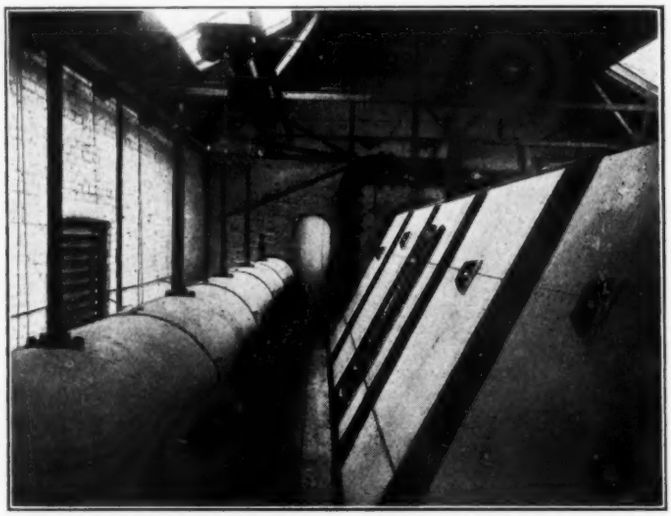


Fig. 4.—Top of Adsorbers on Right Activating Air Outlet Duct on Left.

Silica-Gel Plant at Wishaw Works.

Table II.—*Some Results of the Dehydrating Plant.*

	1925.	May, 1927.	June, 1927.	July, 1927.
Moisture in atmosphere. (Grains per cub. ft.)	3.5	3.08	3.41	4.85
Moisture in blast. (Grains per cub. ft.)	3.5	1.09	1.20	1.61
Output per furnace per week (tons)	356.5	418.5	400.0	417.6
Percentage increase in output	—	17.39	12.20	17.14
Total carbon per ton of iron (lbs.)	2,055	1,961	1,938	1,956
Percentage saving in fuel	—	4.57	5.69	4.82
Carbon burnt at tuyeres per ton of iron (lbs.)	1,705	1,611	1,588	1,606
Percent ge saving in fuel burnt at tuyeres	—	5.51	6.86	5.81
Balance of available hearth heat per lb. of carbon burnt at tuyeres (according to Johnson) (B.T.U.)	1,585	1,724	1,717	1,694
Theoretical saving in carbon burnt at tuyeres (according to Johnson). (Per cent.)	—	8.06	7 69	6.43

time wages as distinct from tonnage, the overhead charges, etc. In Scotland, if the increase in output exceeds the saving in fuel, and there is consequently a bigger coal consumption, overhead charges per ton in the by-product plant will also be reduced, and the net cost of coal will be less.

There does not appear to be any loss of tar with the changed conditions. On the other hand, there is a slight diminution in ammonia recovery, which may be due to the smaller amount of hydrogen in the gases, or may be due to the increased difficulty of cooling the gas, with a bigger coal consumption.

opportunity of exploring the unknown field between 0.1 and 1.0 grain per cub. ft., and it is hoped at Wishaw at a later date to venture into this region.

For controlling such a dehydrating plant hygrometry becomes important. So far, the readings have been taken with wet- and dry-bulb thermometers, care being taken to provide sufficient draft and to keep the wick continuously wet with clean water. A recording hygrometer which would give direct readings in grains per cub. ft. would be a great advantage, if the instrument makers could produce one.

1885.—The Cremer process, using solid calcium chloride or sulphuric acid. The medium was to be placed on double-bottomed trays, thus allowing for regeneration *in situ*. (Cremer was Gayley's predecessor—the process was unsuccessful.)

1890.—Gayley's experimental work on refrigeration begun.

1901.—Notes on experiments were made in the U.S.A. with a view to drying by refrigeration; a plant was to be installed at one of the Carnegie blast-furnace plants.

1904.—Gayley's Paper before the Iron and Steel Institute, giving the first month's figures from Isabella No. 1 furnaces.

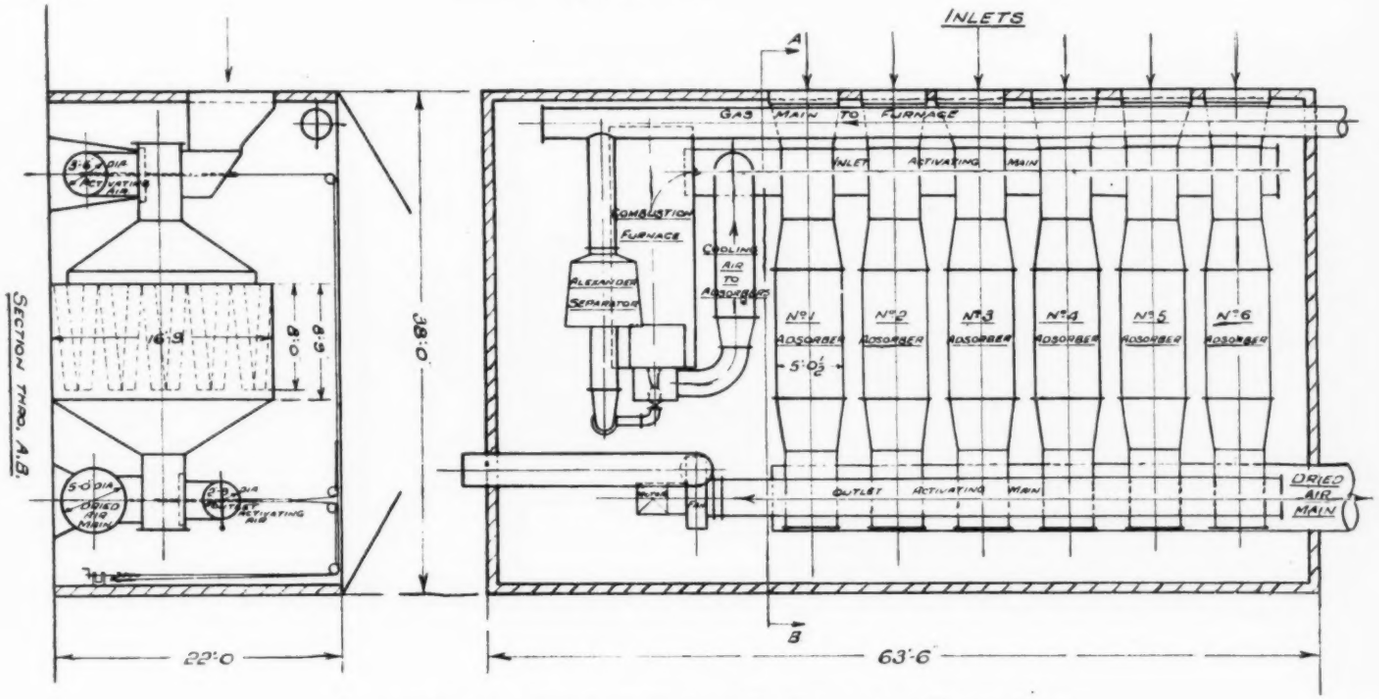


Fig. 5.—General Arrangement of Silica-Gel Plant at the Wishaw Works.

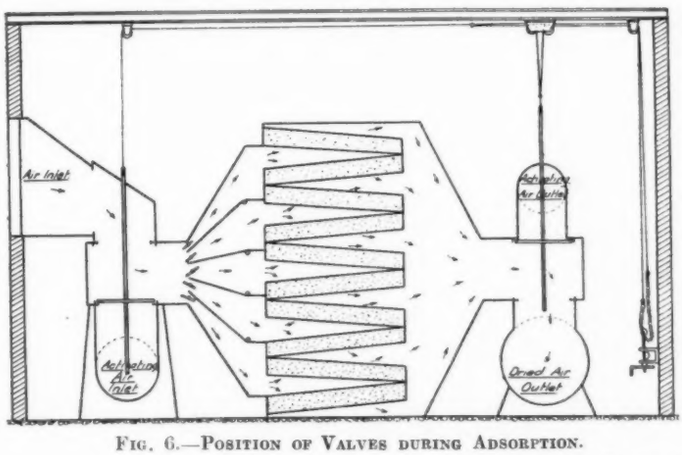


Fig. 6.—Position of Valves during Adsorption.

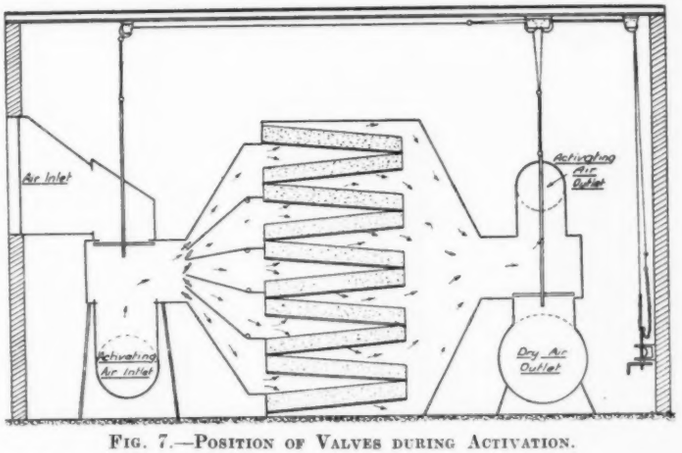


Fig. 7.—Position of Valves during Activation.

Silica-Gel Plant at the Wishaw Works.

The saving will not be quite so attractive to those who need their blast furnaces to act also as gas producers. Taking everything into account, the plant at Wishaw, so far, shows a substantial return on the capital cost.

An interesting question arises as to what is the best degree of dryness in the blast. It seems to be generally agreed that improved furnace operation follows with increased dehydration down to 1 grain per cub. ft. On the other hand, it is known that certain reactions in the furnace are slowed down when the gas is below "calcium chloride" dryness, which represents about 0.1 grain per cub. ft. What happens in between does not seem to be known. Silica gel offers an

The author acknowledges his indebtedness to Mr. Edgar C. Evans for the appended historical notes.

Historical Notes.

1799.—Mr. Dawson, of Lowmoor, before a scientific society in York, pointed out the difference between winter and summer practice.

1853.—Prideaux's "Economy in Fuel" gave suggestions for drying blast.

1869.—The Duke of Devonshire, at the inaugural meeting of the Iron and Steel Institute, mentioned this difference as an important problem to be solved.

1880.—The Fryer process, using solid calcium chloride. The liquor formed was to be collected and concentrated, and the solid so obtained dried and fused, but the process was not worked commercially.

1906.—In a discussion of a Paper by Meissner * Gayley stated that the saving to be expected directly from dry blast was normally about 3 per cent. with a maximum of 7 per cent., and that the remainder of the saving actually made was due to greater regularity in blast-furnace operation.

The Elsner process, using solid calcium chloride, the regeneration being carried out in a lower drum, and the regenerated chloride then elevated to an upper "drying drum."

1907-9.—Refrigerating plant installed at Dowlais-Cardiff plant, and considerable savings quoted.

The Harbord process, using calcium chloride, sul-

* "Transactions of the American Institute of Mining Engineers," 1906, vol. xxxv i. p. 201.

phuric acid, etc. Peat or pumice stone impregnated with the medium, thus giving an increased surface area of the latter. Refrigerating plant installed in South Chicago to deal with 122,000 cub. ft. of air per minute.

1909.—Experiments were undertaken at Clarence Ironworks to determine the effect of uniformity of moisture content. It was shown that considerable quantities of steam could be added to the blast to attain regularity without materially increasing the coke consumption.

1910.—Daubiné and Roy described a calcium chloride process in which the blast was drawn through the chloride, which was water-cooled and arranged for regeneration *in situ*.

A plant was installed at Differdange Works, Luxemburg.

1911.—An ammonia refrigerator plant to be driven by exhaust steam was installed by the Brymbo Steel Company. The moisture was to be maintained below 1.5 grains per cub. ft.

The Miles process, a modification of Gayley's process, whereby the air was cooled in contact with sprays of cold liquid on the outlet side of the direct-acting blowing engines.

1913.—Ehrenwerth stated that the Gayley process at the Deutscher Kaiser Works, Bruckhausen, and the Daubiné and Roy process at Differdange, were out of operation and reported to be unsatisfactory.

1917.—Cammen described a process using calcium chloride solution, in which the brine flowed counter-current to the blast and was then taken to an evaporator and subsequently cooled.

[The author concludes his Paper with a list of references to dry blast that have appeared in technical journals and the "Transactions" of societies, etc.]

Tests of the Fatigue Strength of Cast Iron.

In a report of an investigation conducted by the Engineering Experiment Station, University of Illinois, in co-operation with the Allis-Chalmers Manufacturing Company, by Prof. Herbert F. Moore, Mr. Stuart W. Lyon and Mr. Norman P. Inglis (Holder of the Robert Blair Travelling Fellowship controlled by the London County Council), the following conclusions have been drawn.

Static tests, impact tests, and fatigue tests were made on specimens from four different lots of grey cast iron. Cast iron 91 was from a piece of 6-in. pipe with walls ½ in. thick; this pipe was sand cast by a centrifugal process. Cast iron 92 was from a casting in the form of a 12-in. hollow cylinder with walls 1 in. thick. Cast iron 93 was from a casting in the form of a 12-in. cylinder with walls 3½ in. thick. Cast iron 94 was from the inner wall of a double walled cylinder casting weighing about 25 tons.

The results of the tests should be regarded as giving some suggestive information concerning the fatigue strength of cast iron rather than as giving comprehensive test data. The results of the tests give information on the properties of grey cast iron as a material rather than on the properties of grey cast iron as found in different parts of castings.

The following summary of conclusions is given:

(1) The diagrams plotted from the test data of the fatigue tests of cast iron indicate well-defined endurance limits. The regularity of the test data, as shown by the small amount of "scatter" in the plotted points, is surprising in view of the inclusions of slag and the graphite flakes found in cast iron, and the probable internal strains. The regularity of the test data is further emphasised in the stress-strain diagrams, and other graphical test results, reported in this bulletin.

(2) For the cast irons tested the endurance ratios (ratio of endurance limit in reversed flexure to ultimate tensile strength) varied from 0.33 to 0.46, with an average value of 0.35. This average value may be compared with average values of 0.50 for wrought iron and steel and 0.42 for steel castings.

(3) The specimens from the large cylinder casting (cast iron 94) showed lower values both for ultimate tensile strength and for endurance limit than did the specimens from the castings in the shape of pipes (cast irons 91, 92, and 93).

(4) The endurance limit of specimens of cast iron 93 was increased about 30 per cent., and that of specimens of cast iron 94 was increased about 40 per cent. by the application of a large number of cycles of stress slightly below the original endurance limit. As an explanation of this result, it is suggested that although cast iron shows very little ductility as measured by elongation and reduction of area in a tension test, it develops some inter-crystalline slip with consequent favourable readjustment of stress-distribution without starting a fatigue crack.

(5) The effect of holes and grooves in reducing the fatigue strength of specimens of cast iron 93 was found to be less than the effect of holes and grooves in steel specimens, and much less than the effect indicated by the theoretical stress-intensification at such irregularities. Two possible explanations are offered: (a) the ductility of cast iron, small as it seems to be, is sufficient to allow considerable slip-adjustment of stress without starting a fatigue crack (see conclusion 4); and (b) the large graphite flakes in grey iron constitute "stress-raising" defects of a size comparable with the holes and grooves in the specimen, and hence the hole or the groove adds only slightly to the effect of the regions of weakness inherent in the metal.

(6) Tests at elevated temperatures of specimens of cast iron 92 gave little indication of reduction of either ultimate tensile strength (for ordinary speed of testing) or of fatigue strength up to 425 deg. C., and the proportional diminution of fatigue strength under higher temperatures was found to be slightly less than the proportional diminution of ultimate tensile strength and of Brinell hardness.

(7) Tests were made of the fatigue strength of specimens of cast iron 92 under cycles of flexural stress varying from zero to a maximum in tension. The endurance limit was found to be 48 per cent. above the endurance limit for cycles of completely reversed stress.

(8) Tests were made of the fatigue strength of specimens of cast iron 92 under cycles of axial stress varying from zero to a maximum in compression. The endurance limit was found to be 59 per cent. of the ultimate (static) compressive strength.

Chemical Analysis and the Quality of Pig-Iron.

By E. J. Lowry.*

Chemical analyses are but guideposts, and each pig-iron has a quality all its own. Who has not heard the melter say, "This pig-iron will carry more scrap than that one over there?" Yet the analyses may be exactly alike. What then carries the scrap? It is the quality of the iron base which makes up about 94 per cent. of the mass of iron. The present purchasing of pig-iron, however, is on the basis of silicon content, which ordinarily makes up but 2 to 3 per cent. of the volume. What a peculiar position to be in when buying something. It is not believed that there are many other materials purchased accordingly.

As an instance of this, look back over the analyses of bygone years. Glance at the old cold blast charcoal iron analyses. There one finds a total carbon of about 3.65 per cent. as against some of the present hot blast coke irons with an analysis of 4 per cent. carbon. One finds, however, that the cold blast iron carried from 15 to 25 per cent. more scrap than the present-day coke irons, and the amazing part of it all is that the silicon in the castings was lower. The castings machined just as readily at equal speeds and feeds as the present-day castings, and they were stronger and better. What caused this to happen, if it wasn't the quality of the iron matrix? It surely could not have been the silicon, nor any of the other elements, because the silicon was lower and the carbon was lower. If one examines the rest of the analysis, one would find the phosphorus higher, so much so that the foundryman of to-day as well as the metallurgist, would say that solid castings could not be produced, but they were.

There is a difference between coke iron and charcoal iron. The quality of the castings made from charcoal iron is appreciably better than of those made from coke iron. Why, then, isn't charcoal iron used? Solely because of the price.

Charcoal iron is made under an acid slag, whereas the coke irons are usually made under basic slags. The more nearly the coke-iron furnace operates on an acid slag, the more nearly the quality approaches charcoal iron. The acid slag tends to give a different reaction to the smelting of the ores and to give a different carbon formation in the resulting pig-iron. These carbon formations persist through the melting operation into the casting. The carbon formations in the pig-iron influence the resulting matrix in the casting, producing what resembles pearlite when the temperature of pouring, rate of solidification and other factors are in balance.

From such a combination castings are produced which give the greatest machinability, the longest wear and the least expansion or growth. No matter what the field of castings, these quality elements are essential. The automobile cylinder maker is confronted with the problem of machineability, wear and expansion. The same is true in piston ring manufacture, but in these two groups different irons are used and different analyses enter the castings. The result is that high grade engines often give trouble because one part or another wears out. When the block is dismantled, it is found that wear on the piston ring has been greater than that on the block or *vice versa*. If the wear had been equal, the longevity of the engine would have been increased.

The machine tool builder is confronted with the problem of warping and growth. He tries to "age" his castings to overcome this, but if he would pay more for his pig-iron or other raw materials, he would find he could prevent growth and warping without carrying a large stock of castings. The interest charges on his present large inventory would be cut down and would aid in offsetting the increased price of quality materials.

The great trouble with the foundry industry to-day is that because of price the melter is required to use a pig-iron which is sometimes unsuitable for his casting work.

If present furnaces could be operated at temperatures hot enough to destroy the inherent qualities of pig-iron, we would then become successful in employing a large percentage of tramp materials and make castings which would be surprising in their strength and other physical properties. These temperatures would range from 1,535 to 1,850 deg. C., depending upon the materials under consideration. The German investigator, Piwowarsky, has shown this to be the case. He sets forth claims that at such temperatures he destroys the "germs" which are inherent in pig-iron and scrap, and for which we cannot inoculate our irons to prevent their ill-effects.

* Metallurgist Hickman, Williams & Co. and Witherbee-Sherman Co., New York. "Iron Age" abstract of address before National Association of Purchasing Agents at Grand Rapids, Mich., June 7.

British Steel and the Schneider Cup.—Sir Samuel Hoare, referring to Flight-Lieutenant Webster's victory in the Schneider Trophy race when he attained the phenomenal speed of 284.14 m.p.h., described this British success as providing one more proof of the unsurpassed excellence of British personnel and materials. A notable contribution both of material and workmanship to this British success was that of Messrs. Vickers, Limited, who were responsible for the steel and manufacture of the crankshaft and the connecting rods of the Napier "Lion" engine installed in the Supermarine Napier S.5. This constitutes the fourth record-breaking achievement during the current year in which Vickers steels have proved their incontestable excellence. It may be recalled that the frame, gears, axles, shafts, etc., of Captain Malcolm Campbell's "Bluebird" car, with which he achieved a speed of 174.883 m.p.h., were made of Vickers steels, as were also all the vital parts of Major Segrave's 1,000-h.p. Sunbeam car, with which he set up a world's record of 203.841 m.p.h. These two achievements were followed by the remarkable performance of the Bentley car which covered 1,472.64 miles (61.36 m.p.h.) in 24 hours at Le Mans, thus winning for Great Britain the 24-hour Grand Prix d'Endurance. The crankshaft—the heart of the engine—of this car was of Vickers manufacture.

The Constitution of Silicon-Carbon-Iron Alloys and a New Theory of the Cast Irons.*

Slightly Abbreviated.

By Professor D. Hanson, D.Sc. (Birmingham).

(*Continued from page* 282.)

Experimental Verification of the Theory.

The above theory may now be examined in the light of the experimental evidence. In the first place, the theory is based on the fundamental assumption that the iron-carbide and iron-graphite systems intersect at a point on that boundary of the austenite field representing carbon solubility. Ample experimental evidence has already been advanced for that assumption. By the simple application of the known laws of equilibrium in ternary systems, the consequences of that assumption have been analysed, and five possible forms of equilibrium diagrams have been deduced representing the constitution of the ternary alloys, namely, Figs. 13, 14 and 15, and two others, not reproduced, similar to Figs. 14 and 15, except that carbide must be written for graphite and *vice versa*. But if the theory is correct, the experimental diagrams should possess the form of one of these theoretical possibilities, all of which possess their own peculiarities, and are readily distinguishable. A comparison shows that the experimental results can be represented completely by a diagram in the form of Fig. 14 and by none of the others. Figs. 5 and 6 contain all the phase fields of Fig. 14, and no others. Fig. 4 is of the same type, but in this instance the two fields representing (γ + C + graphite) and (γ + C) have been inserted, without experimental evidence, since alloys suitable for verifying their existence were not available. The experimental results, therefore, constitute very strong support for the theory.

Application of the Theory to the Cast Irons.

The present Paper would be incomplete without some account of the manner in which the properties of the iron-carbon alloys, especially the cast irons, can be explained by the author's theory. It can clearly not yet be applied in detail to account for all the phenomena of complex cast irons, containing elements whose influence has not yet been investigated (manganese, sulphur, phosphorus, etc.), to which reference will be made below; but it can be used to account for the general behaviour of most cast irons, in which the influence of silicon and carbon are predominant. In the following analysis such irons only are considered.

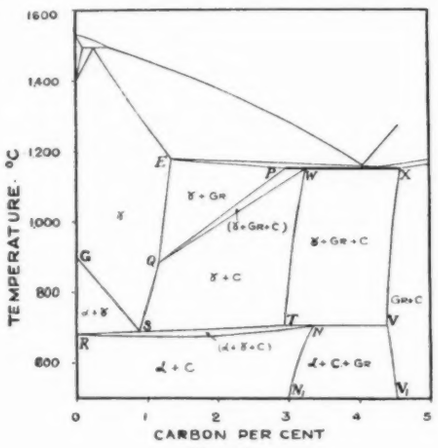


Fig. 15.

In the first place, the theory accounts for the existence of graphite as a stable form of carbon in high-carbon alloys (cast irons), whereas cementite alone is found in low-carbon alloys (steels). In most of the ordinary cast irons of commerce experiments have clearly demonstrated that graphite is the stable form of carbon. The diagrams (Figs. 4, 5 and 6) clearly account for this fact, for they indicate graphite as the stable form in all alloys containing more than 2 per cent. of carbon and 0.4 per cent. of silicon, with the exception of a short range of temperature, in the region of 700 deg. C., in which some carbide can exist when the silicon content is low. The ordinary cast irons practically all fall within the range of composition in which graphite only is the stable form of carbon. It is only in certain kinds of malleable iron, to which reference will be made below, that carbide can exist as a stable phase.

The proved stability of graphite in cast irons has frequently been regarded as evidence that iron carbide is everywhere unstable; this view is still widely held, although experimental data in its favour are scanty and not very convincing. Indeed, the weight of evidence seems to be against this view, for not only is iron carbide extremely

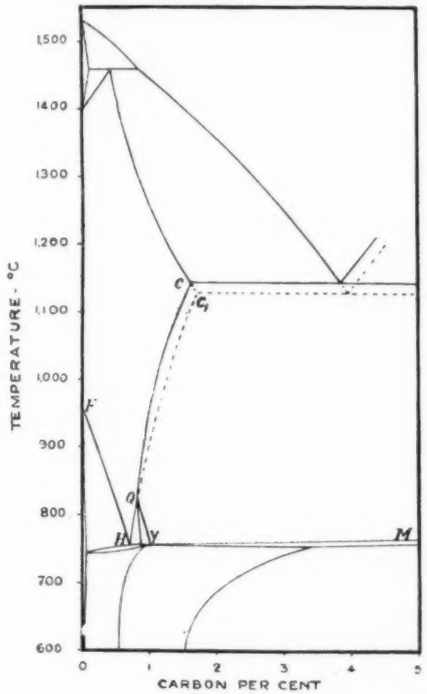


Fig. 16.

stable under heat in the steels, but it may be synthesised readily in a variety of carburising media at temperatures at which it is held to be unstable. The author's theory is consistent with the stability of iron carbide in the range of the ordinary steels, and his equilibrium diagrams in this range of composition require no modification in principle from those normally accepted and used. The intermediate types of alloy, in which both forms of carbon are stable, are scarcely represented in commercial alloys, as they fall in the zone of little usefulness between the steels and cast irons. Many of the author's alloys, however, fall within this region, and the study of their constitution has made it possible to bridge the gap between the steels and cast irons and arrive at a proper understanding of their true relationship.

There is thus presented for the first time a theory which accounts, qualitatively, for the existence of graphite as the stable form in cast irons, and iron carbide in steels, the case being completed by the demonstration of an intermediate zone of alloys in which both forms can exist together.

It must be noted that the possible existence of graphite as a stable phase in pure *high* carbon-iron alloys is not excluded. There is a certain amount of evidence that it can occur; the author's experiments have not extended to this region. Its existence would not affect the present work nor the conclusions drawn from it.

The author's theory may be regarded as superseding the double diagram for iron-carbon alloys, for it represents the facts relating to equilibrium conditions by means of ternary equilibrium diagrams: they are really sections through the ternary equilibrium model. But commercial irons are not usually in a condition of complete equilibrium, and a double diagram may well be utilised to account for a departure from equilibrium. Such a diagram can be logically developed from the equilibrium sections by producing the line *HQ* (Figs. 4, 5 and 6), representing the solubility of carbide in austenite, until it meets the austenite solidus line. From this latter intersection a metastable austenite-carbide eutectic zone commences, extending to regions of higher carbon content. Fig. 16 represents this diagrammatically (since the author has no reliable quantitative data), the dotted portion representing the metastable diagram. The iron-carbide eutectoid may be similarly extended to complete the metastable diagram, but it is not shown in Fig. 16 on account of the complicated character of this lower region. A diagram, partly stable and partly metastable, representing the relations between iron and iron carbide in these ternary alloys may thus be realised, and if graphite formation can be prevented, this diagram should represent, qualitatively, at any rate, the behaviour of the alloys. That it does do so is evident, for it is known that by suitable chilling graphite formation is prevented, and structures (white iron) entirely consistent with the carbide diagram are produced.

The theory will well account for some of the phenomena of graphitisation in white irons. These irons, produced as described above, according to the metastable system by the rapid cooling of low-silicon irons, deposit graphite when reheated and cooled slowly. During the first stage of graphitisation graphite separates from austenite, according to the stable diagram, and possibly also by direct decomposition of carbide, until immediately above the critical range austenite and graphite are the only phases present. But it is known that to secure complete graphitisation cooling must be slow, and must continue to well below the critical range (about 750 deg. C.). In Blackheart practice it is considered essential to cool *very slowly* from 750 deg. to 650 deg. C., to complete the graphite formation. Slow cooling favours the separation of graphite, but graphitisation can never be complete until the critical range is passed, for immediately above this temperature the austenite has the eutectoid composition. Now, according to the older double diagram theory, graphitisation should become complete upon annealing just below the critical range, say 740 deg., C., but, in fact, it is known that this does not happen, and that a temperature range of further graphitisation occurs below the eutectoid. This is explained by the new theory, for there are shown to exist within the range of white iron compositions alloys in which carbide is stable with ferrite and graphite below the eutectoid; the shape of the diagram (the line *SX*) indicates, however, that this carbide is rapidly dissociated as the temperature is further reduced, and at 650 deg. C. all irons in the commercial malleable range consist of ferrite and graphite only, when in equilibrium.*

The influence of other elements has naturally not been considered, since no experimental

* A Paper read before the Glasgow Meeting of the Iron and Steel Institute.

* The above only applies to graphitisation phenomena in which oxidising agents play no appreciable part. The equilibrium between iron and carbon is known to be greatly affected in the presence of oxygen (CO and CO_2) and requires separate consideration.

evidence bearing on this aspect of cast irons has been obtained. Nevertheless, the theory appears to be capable of extension in a simple manner to take account of such influence, provided that new phases are not introduced into the more complex alloys. It is known that certain elements, as, for example, manganese and chromium, tend to increase the amount or stability of carbide, while others, such as nickel and aluminium, promote graphite formation. The addition of another element to such a system would be expected to alter the transformation temperatures. In the present case a very small alteration in the relative positions of the carbide and graphite solubility lines would have a relatively large effect on the position of their intersection, that is, the point *Q*, and consequently on the carbide-graphite equilibrium, for it is mainly on the position of *Q* that the stabilities of these two phases depend.

There is another fact which must be accounted for by any theory of cast iron. It is well known, though not always sufficiently recognised, that the character of cast iron depends on the amount of carbon present quite as much as on the amount of silicon, and that high carbon promotes graphite formation, just as does high silicon. Carbon and silicon may be regarded as replaceable in this respect, though not necessarily in equal amounts. White iron can be made with high carbon if the silicon be low, and with high silicon, if the carbon be low (the latter is more correctly a steel). Similarly, graphite can be the stable form with low-silicon iron, provided the carbon is high, and in low-carbon alloys, if the silicon be increased.

The essential differences between the Whiteheart and Blackheart malleable processes now become more intelligible. The European process favours carbide stability below the eutectoid, since the malleabilising consists in carbon elimination; the American process retains the carbon in the iron, and throws the equilibrium into the region of graphite stability. The difference in the sulphur content, of course, is also a vital factor, acting in the same direction, in the manner explained above.

These facts find recognition in the author's theory of ternary equilibrium, in which the carbon condition is determined by the composition of the alloy; either form may be stable, or both may exist together, and variations in carbon concentration may alter the equilibrium as well as variations in silicon. A glance at any of the diagrams of Figs. 4, 5 or 6 shows that as the carbon increases in concentration, even though the silicon remains constant, so does the stability of graphite increase until it becomes the only stable form of carbon. The double-diagram theory fails to express the above facts, since it shows only one form of carbon as stable.

Rate of cooling may be regarded as another variable in the system, affecting it in a manner that is qualitatively similar (though not necessarily quantitatively) to variation in silicon, an increase in the rate of cooling being structurally similar to a reduction in silicon content. In this respect, also, the author's theory appears preferable to the double-diagram, which can only assume a complete change from graphite to carbide stability with variation in the cooling rate, and cannot therefore account for the most commonly occurring cast-iron structures in which both forms of the carbon are found.

The above application of the author's theory to the cast irons is not claimed to be quantitatively exact; the amount of work required to make it so is very great; the theory does, however, appear to offer an explanation of the main facts relating to the cast irons, for which no other theory so far advanced is adequate.

Discussion.

Dr. W. H. Hatfield thought that all the members who dealt with theoretical aspects of such questions must welcome the fact that the author's work would reawaken an interest in the iron-carbon diagram. That certainly required doing, because they did not possess at the present time sufficient experimental data even to attempt to draw a final diagram. A little time ago he was interested in looking for the most reliable iron-carbide diagram he could find. He turned up the new International Tables and was there referred to the iron-carbide diagram produced by a distinguished member of the Institute, and he found that the whole of the region with which the author dealt included the carbide phase. He did not believe that that could be true, but the difficulty was great because experimentally it could not be said it was not true. A decision could not be given because a perfectly pure iron-carbon series covering the whole range had not been done and adequately experimented upon. It was therefore very satisfactory that the author had commenced to work on the subject. A series of alloys was given in Table II, but quite clearly that was not a suitable series for adequately tackling the job the author had undertaken, because all those alloys were under the eutectic composition. Later the statement was made that "Fig. 26, in particular, shows clearly primary austenite grains embedded in a very fine matrix of austenite-graphite eutectic." There was no such thing as an austenite-graphite eutectic. If the author would study some Papers which he (Dr. Hatfield) would send him he would find at any rate very strong circumstantial evidence, quite enough to hang him on, that the austenite-graphite eutectic did not come into existence. It was the austenite-carbide, and then the carbide decomposed. The author spoke of the old European process as being simply one of decarburisation. It was not. It was a case of precipitation just as in the American process, the only difference being that the presence of a higher sulphur content prevented the carbide which separated at the eutectic point from dissociating. If a large number of samples were studied it would be found that in a properly decarbonised European white iron there was a graphitic content which might be as high as 2 per cent. He hoped the author would continue his attempt to give a proper shape to the diagram, and he thought all the members ought to take a great interest in that attempt. It must always be remembered, however, that solid metallic systems were very difficult to deal with, because difficulty was experienced in getting proper equilibrium. For instance, he might be shown a micro-section which contained graphite and carbide, and therefore it might be said that the two phases were in equilibrium at a given temperature. Probably it was nothing of the kind. It might be the case that the carbide breaking point set up a pressure which eliminated further dissociation. In his opinion it was a more simple explanation than the one the author had put forward.

Mr. J. H. Whiteley was inclined to agree with the view set forth by the author in his very interesting Paper. It had always seemed to him for many years past that it was possible to have both graphite and cementite stable in iron under certain conditions, and the author's view that it was possible to have two systems which interlocked at certain points was a very feasible one. The only point of criticism he desired to advance was in regard to the author's statement that: "It will be observed that the eutectoid point in the iron-cementite system occurs at a lower carbon content as the silicon is increased." He had looked carefully through Table II, and could only find one alloy with a composition anywhere near the eutectoid composition, *i.e.*, the alloy *SC*9 containing 0.82 carbon. Nevertheless, the author, in Figs. 1, 2 and 3, plotted

Fig. 17.—*SC*8. Cooling - Curve Ingot. × 1,250.

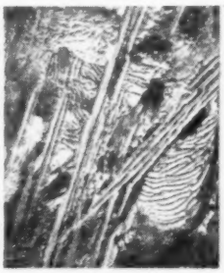


Fig. 18.—*SC*11. Cooling - Curve Ingot. × 1,250.

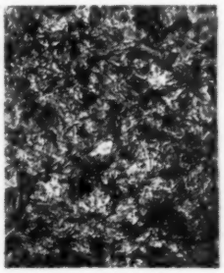


Fig. 19.—*SC*12, Cooling - Curve Ingot. × 1,250.

Fig. 20.—*SC*12. Cooling - Curve Ingot. × 1,250.

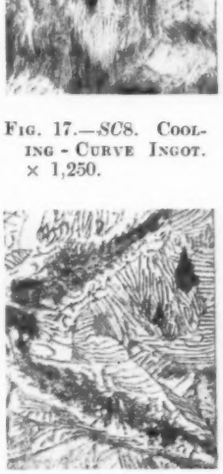


Fig. 21.—*SC*13. Cooling - Curve Ingot. × 1,250.

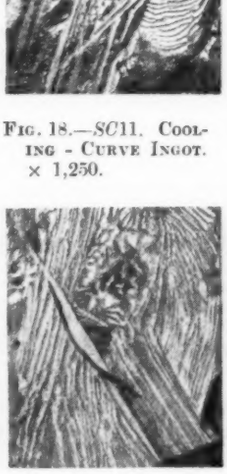


Fig. 22.—*SC*14. Cooling - Curve Ingot. × 1,250.

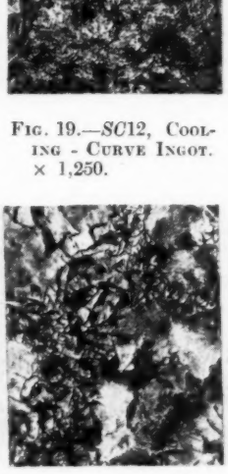


Fig. 23.—*SC*16. Cooling - Curve Ingot. × 150.

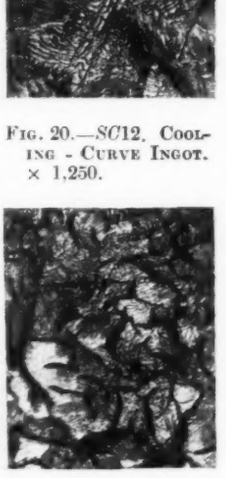


Fig. 24.—*SC*18. Cooling - Curve Ingot. × 1,250.

Fig. 25.—*SC*19. Cooling - Curve Ingot. Etched. × 150.

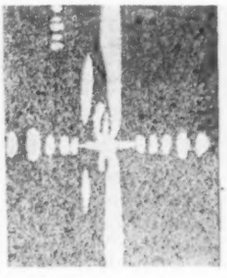


Fig. 26.—*SC*19. Original Ingot, as Polished. × 150.

Fig. 27.—*SC*4. Quenched from 730 deg. C. Etched. Showing Constituent X. × 1,400.

Fig. 28.—*SC*6. Quenched from 738 deg. C. Unetched. Showing Constituent X. × 1,400.

(All reduced in reproduction to slightly less than one-half.)

three points and drew the line CH through all points. He hoped the author had other data, because if the remainder of the Paper was built on similar lines he was afraid a great deal more work would have to be done before the results could be corroborated.

Mr. M. L. Becker thought the most important suggestion, and the one upon which the whole scheme seemed to depend, was that in which the author suggested that iron carbide was stable and not graphite below a certain temperature. Referring to Fig. 14, the temperature of that would be represented by the point Q. It seemed to him there was evidence that carbide was unstable within that given range. From other work which he had carried out, he knew from a comparison of the carbon rate of pressure of the two phases that carbide had the higher carbon rate of pressure, *i.e.*, they had the right to assume that graphite would be the more stable form. Although he knew that Fig. 14 was really the section of a ternary diagram, in the binary diagram for pure iron carbon the point Q must appear in more or less the same position as that shown in Fig. 14. Even with 0.5 per cent. of silicon there was quite a large range where carbide was stable. He thought he possessed quite a lot of evidence which showed that that was not the case. Any attempt to explain the anomalies which had been so frequently noted in connection with the cooling and graphitisation of cast iron was extremely useful at the present time. There were plenty of anomalies which were not yet understood, and for the moment he felt rather critical about the question of the stability of graphite.

Professor Hanson, in reply, said he would deal in a written communication with most of the questions raised. He did not agree with the attitude which Dr. Hatfield had taken up, that the only alloys that could be stable in an investigation of that nature were the alloys with which he was accustomed to deal commercially. He desired to tell Dr. Hatfield that if those alloys had not been there, it would have been quite impossible to investigate the very important region in which both graphite and carbon were unstable. It was simply by taking alloys that were not used commercially that it was possible to throw a little light upon the important range between the two. It was impossible to make commercially the sort of alloys with which he dealt. If Dr. Hatfield could do so, he would take advantage of the kind offer that had been made to obtain some of the materials from the producers, because that would save him an immense amount of trouble in preparing them. If Dr. Hatfield could make those alloys commercially with the degree of purity that the alloys referred to in the Paper contained, he accepted without hesitation Dr. Hatfield's offer to supply him with them for the purpose of carrying out his experiments.

Fig. 29. — *SC*7. Quenched from 780 deg. C. Etched. γ (Martensite) + Graphite. × 300.

Fig. 30. — *SC*7. Quenched from 765 deg. C. Etched. γ (Martensite) + Graphite + Pearlite. × 300.

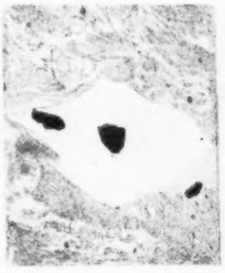


Fig. 31. — *SC*7. Quenched from 752 deg. C. Etched. Graphite + Ferrite + Carbide (Pearlite). × 150.

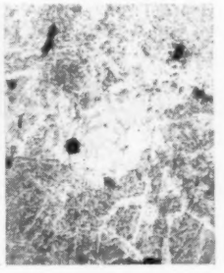


Fig. 32 — *SC*10. Quenched from 780 deg. C. Etched. Graphite + γ (Martensite). × 150.

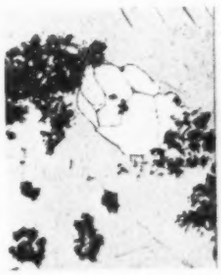


Fig. 33. — *SC*10. Quenched from 765 deg. C. Etched. Graphite + Ferrite + (Martensite). × 300.

Fig. 34. — *SC*10. Quenched from 750 deg. C. Etched. Graphite + Ferrite + Carbide (Pearlite). × 150.

Fig. 35. — *SC*10. Quenched from 730 deg. C. (Centre of Specimen). Etched. Graphite + Ferrite. × 150.

Fig. 36. — *SC*10. Quenched from 730 deg. C. (Surface of Specimen). Etched. Graphite + Ferrite. × 150.

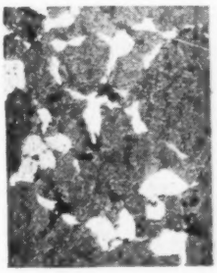


Fig. 37. — *SC*13. Quenched from 765 deg. C. Etched. Graphite + Ferrite + (Martensite). × 150.

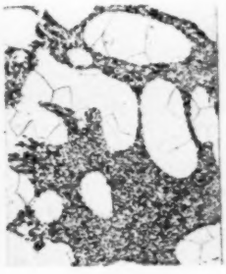


Fig. 38. — *SC*16. Quenched from 765 deg. C. Etched. Graphite + Ferrite. × 150.

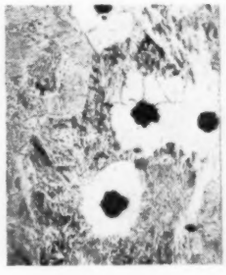


Fig. 39. — *SC*8. Quenched from 663 deg. C. Etched. Graphite + Ferrite + Carbide (Pearlite). × 150.

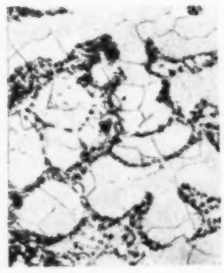


Fig. 40. — *SC*14. Quenched from 663 deg. C. Etched. Graphite + Ferrite. × 150.

(All reduced in reproduction to slightly less than one-half.)

Developments in Metal Spraying.

Interesting applications of the Schoop process of metal spraying for the repair of castings and machine parts and for adding heat resisting qualities to metals have been made by the Metals Coating Company, Cleveland, Ohio.

An important function of this process, which has been described in these columns, is the applying of coatings of various metals to metals as a protection against atmospheric corrosion and for decorative purposes. The metal is applied to the surface to be coated or repaired in a very fine spray by a Metalayer, as the apparatus used for the work is known. This is in the form of a gun weighing 3½ lb., in which standard gauge wire of almost any metal is automatically fed to the nozzle of the short barrel. There it enters a continuous reducing flame developed from the burning of gas, such as acetylene. When melted it is blown by the compressed air, also delivered to the gun at a high velocity against the surface of the work.

The process is being used successfully by the Cleveland company in building up machine tool parts to overcome the defects caused by the removal of too much metal in machining. The metal is applied in a coating of the desired thickness to the section that is to be built up, and then the surface is ground to the proper size. Another example of the work is the building up to the proper dimensions of a forged crank shaft for an automobile with nickel steel. Surfaces of the built-up sections are reground after the coating is applied.

Heat Resisting Coatings to Case-Hardening Boxes.

Another recent use of the process is the applying of coatings to secure a hard heat resisting metal. Cast-iron boxes used in case-hardening, scale and sometimes warp under the effects of the heat, and these have been coated with nickel chrome steel either when new or after they have had some use. Cyanide pots and lead pots have also been given a chrome nickel coating for the same purpose. Aluminium is being similarly applied to pyrometer couples as a heat resisting metal.

A Cleveland motor car manufacturer is now experimenting with the process for putting an aluminium coating on automobile exhaust pipe intakes, manifolds and hot spot castings with the view of having these parts aluminium coated as a substitute for vitreous enamelling. It is pointed out that parts already machined sometimes warp when subjected to heat in the enamelling operation, and that danger of distortion is avoided by the use of the metal coating.

Reclaiming Castings.

The Schoop process is being used by the Cleveland company as a substitute for welding, for repairing defects in various castings due to sand and gas holes. In the automotive field it is being used mostly for repairing crank case castings. For automobile repair work the process is said to be proving both successful and economical for repairing scored cylinders, cracked water jackets and leaky radiators. An advantage claimed for the process in repair work of this kind is that no preheating is required.

Work to be coated or repaired is usually taken to the company's plant, but if large castings are to be repaired the apparatus is taken to the work. Most foundries are provided with compressed air and gases needed for doing the work in their plants.

The use of the process for applying decorative coatings on metals has been extended to the coating of materials other than metals. The Cleveland company is using it for putting a bronze coating on plaster of Paris statues and on other pieces of the same or somewhat similar materials used for decorative purposes.—"The Iron Age."

The Future of the Non-Ferrous Casting Industry.

By Wesley Lambert, Vice-President of the Institute of British Foundrymen.

Not long since the writer happened to overhear a somewhat one-sided conversation at an exhibition stall whereon was displayed a collection of chromium-plated cast pieces of iron and steel. From the spoken words it was obvious that, of the parties engaged in conversation, Mr. A was the exhibitor and Mr. B a manufacturer of non-ferrous hardwear. "Well, what price non-ferrous castings now?" said Mr. A, a remark which, although not worded in approved academic style, carried a significance quite understandable doubtless to the readers of this journal. Mr. B, in response, merely ejaculated "Ah!" accompanied by much wagging of the head. Mr. B was evidently in a pessimistic frame of mind. If all the claims made for chromium-plated ferrous parts can be met, the placing upon the market of such chromium-plated iron and steel parts may conceivably react upon the non-ferrous casting industry, but in the writer's opinion there is little to fear in this direction. Rather should one regard the process of chromium plating as being also complementary to the non-ferrous industry than as one having a tendency to be destructive of that industry.

The non-ferrous casting industry, although classed among the most ancient of the arts and crafts, is without doubt still merely in its infancy as regards its commercial possibilities. In prehistoric days only six metals were in use, namely, gold, silver, iron, copper, tin and lead. The very early Chinese and Japanese writers make mention of only five, namely, gold, silver iron, copper, and tin, designated "the five metals." The Greeks and Romans knew also of quicksilver in addition to the six metals named, and these seven metals, with the possible exception of zinc, remained the only ones separated until three or four hundred years ago. To-day we are acquainted with the properties of sixty metals, excluding iron, each of which has been separated and exhaustively examined. All are solid with the exception of mercury; the lightest, lithium, is only little more than half the weight of water bulk for bulk, whereas a mass of iridium is more than twenty-two times the weight of an equal mass of water. To repeat, "What price the non-ferrous industry now?" with sixty metals to play with and the prospect of further additions. The practically illimitable number of combinations and permutations of these sixty non-ferrous metals compounded among themselves offers such a promising field of discovery as to afford no qualms in the writer's mind as to the future of the non-ferrous industry.

Aluminium and Aluminium-Alloy Castings.

The romance of the aluminium and aluminium-alloy casting industry may be taken as an instance of the close co-operation between metallurgical science and industry. Aluminium was first isolated in 1825-27, although many years previously (1760) it was forecast that certain clays would yield a metal if means could be found to smelt the earths of alumina, from which earths alumen—probably our potash alum—was obtained and sold to the ancient dyers. Incidentally, the word aluminium is derived from lumen—light—probably an allusion to the "brightening" effect on colours of the alumen used by the dyers of ancient times. Aluminium, although first isolated one hundred years ago, was fifty years afterwards still being exhibited in museums as a curiosity, and its very limited use was almost strictly confined to jewellery. The first article made of aluminium was a rattle for the infant Prince Imperial, son of Napoleon III, who financed the early experiments. Not until 1886, in which year Hall discovered how to obtain aluminium from alumina—oxide of aluminium—dissolved in molten cryolite, was any considerable progress made in the isolation in bulk of the metal, and in 1889 it is within the writer's knowledge that a solid block of aluminium weighing half a ton was considered of such interest as to be included as an exhibit at the Paris Exposition of that year. After the discoveries by Hall, twenty-five years elapsed before we find the production of aluminium in bulk fully established as a commercial undertaking. To-day, in America alone, the metal is being produced at the rate of over 175 million pounds per annum! The foundry at the works of one automobile manufacturing company recently visited by the writer was turning out over 60 tons of aluminium-alloy castings per week. The aluminium-alloy castings on show at the recent exhibition held in Paris under the auspices of the Association Technique de Fonderie were of such an intricate character and of such diversity of shape and size, the weight ranging from a complete full-size under-frame for an automobile—a one-piece casting—to small castings of one or two ounces in weight, as to impress upon the visitor to the exhibition the fact that, so far as the non-ferrous casting industry is concerned, it has a very healthy baby to foster in aluminium and its alloys. Chromium plating may have its uses, but it is not likely to arrest the growth of the light-casting foundry industry.

Magnesium and Magnesium-Alloy Castings.

The use of the designation "light castings" naturally leads to the mention of yet a further development in this category of castings now available for the use of the engineer, namely, the magnesium alloys of the so-called "electron" type. Magnesium, until quite recent years, was commonly known only in two forms, as metallic ribbon and powdered, and, so far as popular use was concerned, both these forms of magnesium were associated with means of producing an artificial illumination for photographic purposes. A further use of magnesium in connection with the manufacture of material for pyrotechnical products, and to a limited extent as an alloying metal with aluminium, practically exhausted the uses of magnesium outside the laboratory. To-day many parts for light machines and appliances are being cast wholly of magnesium or in alloys of the metal in which magnesium predominates. The present-day employment of magnesium as a reliable casting metal for the use of the engineer has been brought about by the patient scientific work which has been expended in purifying the metal and the close study of its properties. Service trials with magnesium pistons for internal-combustion engines have established it as a very desirable metal to meet peculiar conditions, and the writer has recently seen a full-size cast-to-shape aeroplane propeller in magnesium metal, for which great claims are made. Magnesium is little more than one-half the weight of aluminium bulk for bulk, and the mechanical strength of the metal *per se* and in its alloyed form compares very favourably with aluminium and its alloys.

It is not the writer's intention to discourse upon standard and other alloys of either aluminium or magnesium; the pages of the technical journals and Press are readily available to those concerned. Suffice it to remark that the interest shown in the light alloys is such that the literature available to the student regarding these alloys exceeds in bulk, if not in value, the whole of the present and past publications relating to iron and steel, covering a period of over half a century. Of the cast parts now being regularly manufactured from the light alloys of the aluminium and magnesium category may be mentioned aeroplane, automobile and motorboat parts, engine frames, gear cases, pistons, dash boards, sumps, window and door frames, pump bodies, impellers, fan bodies, electrical fuse and switch boxes, motor and dynamo castings, vacuum cleaners, food mixers, oil separators, scientific and mechanical instruments, tools, automatic machines, domestic appliances, typewriters, duplicating machines, etc., etc.

Die-Casting.

One cannot dismiss the subject of the light alloys without briefly referring to the non-ferrous die-casting industry, which is of comparatively recent introduction. Lead-base, tin-base, zinc-base, and aluminium-base metals are all in use to-day, and both pressure and gravity die-cast parts are being produced in immense quantities in Great Britain and the other industrial countries throughout the world. The production of die-castings in brass and aluminium bronze is also worthy of mention, and may be regarded as supplementary to the foregoing. The merits of the products of the die-casting process are common knowledge; the difficulties and "snags" to be overcome before successful production is attained is admittedly another story. To enumerate the thousands of pieces included in the category of die-cast parts would necessitate the compiling of a vocabulary of fittings running into many pages.

High-Tensile Brasses.

The inclusion of aluminium bronze as a die-casting metal leads one to pay tribute to the patient study and to the development of the high-tensile bronzes, which has resulted in the non-ferrous industry being able to hold its own against the severe competition engendered by the introduction of steel castings. Notwithstanding the high price of the constituent metals entering into their composition, the demand for castings in high-tensile cupreous alloys is an ever-growing one, and the recent great war afforded an opportunity for demonstrating the merits of cast parts in these alloys, and of establishing a measure of confidence which the use of these alloys fully justifies. High-tensile non-ferrous castings are in many instances replacing steel for all parts where homogeneous and thoroughly trustworthy castings are essential. Castings of manganese bronze are in great demand for marine propellers, whether cast whole or built up. This metal finds a ready market also for high-duty castings, such as gun parts, torpedo-firing tubes, submarine conning towers, engine-bed castings, engine-frame castings, stay and bracket castings, pump cylinders, high-pressure valves, ships' fittings castings, pontoon and boat castings, shafting-frame and lever-guide castings, marine-engine castings, general machinery castings, mill and machine parts, rotor rings, rotor end caps, rotor castings, automobile castings, gear and bevel wheel castings, etc. For many of the parts enumerated above, aluminium-bronze castings are equally suitable. Of the two alloys, in the foundry, manganese brass is perhaps more favoured than aluminium bronze, it being generally conceded among founders that of the two alloys the latter is the more difficult to handle in the foundry.

With the introduction of scientific control and the better knowledge throughout non-ferrous foundries of the idiosyncrasies of each of the non-ferrous alloys in common use, and the wonderful field yet to be explored, the writer has no hesitation in affirming that homogeneous non-ferrous castings to meet almost every requirement called for in engineering practice can readily be produced and supplied under a guarantee which should satisfy the most exacting of engineering specifications. Much may be written of many other alloy castings in metal specially compounded for particular service, such, for instance, as gear wheels, axle boxes, abrasive wear-resisting parts, high compressive stress members, acid-resisting plant, superheat steam fittings, heat-resisting details, slide valves, liners, chemical plant, etc. What price the future of the non-ferrous industry? The writer is not among the ranks of the pessimists of the Mr. B. type. There will always be a demand for good, sound non-ferrous castings notwithstanding the pseudo representations made on behalf of ferrous metals clothed in non-ferrous platings and coatings which are often analogous to the proverbial wolf in sheep's clothing. With sixty metals available for alloying purposes, and cheaper production of non-ferrous castings, not by reduction of wages, but by the introduction of up-to-date scientific methods, efficient plant, and the refining and classification of scrap, thus avoiding extravagant waste of fuel and motive power, metal, refractories, fluxes, core oil, mould dressings, etc., will provide all that is necessary to meet a demand which can never fail to be forthcoming for many generations, if ever.

Mr. J. W. Bunting, of the Bunting Brass and Bronze Company, Toledo, U.S.A., is now visiting Europe (with a view to extending his firm's business).

Foundry Purchasing.—XIV.

By Eric N. Simons.

The collection, compilation, and expression in various ways of statistics relating to buying is essential if the buyer is to have an adequate grasp of his occupation and departmental position. Certain men believe in memory, and pride themselves upon the ability to retain longer than most of their colleagues the facts and figures that affect their work. But memory, however good—and its importance none will deny—is at best a fallible guide. The efficient buyer uses his memory when the required statistics are not immediately available, but he takes care to see that his memory is both confirmed and supplemented by proper records. This means that he arranges for the classification, compilation, collation, expression, and so forth, of all the information he needs, sees that it is kept in a convenient form and place, and above all, that it is used.

How, briefly, is this done? And what sort of material is actually needed? Naturally, the buyer does not want to have the valuable time of his staff taken up in accumulating a useless mass of information that he is never likely to want, nor does he want to waste effort in assimilating "dead" stuff. His statistical records must be up to date, accurate, and of definite value. The main classes of facts required are as follows:—(a) The extent and character of former purchases; (b) prices paid on former occasions; (c) information regarding sources of supply, their past, present and future outputs, etc.; (d) potential purchasing needs over a given forthcoming period; (e) current prices, market quotations, etc.; (f) specifications and analyses of goods bought or to be bought; (g) reports from works, customer, or user, on materials bought, tested, or offered; (h) reports from laboratory on goods examined, and (i) information concerning the goods given by their suppliers, *e.g.*, catalogues, pamphlets, and so forth.

All this information is obtained by the statistical clerk from the following sources: advertisements, catalogues, trade publications, market bulletins, works departments, past order books, the laboratory, current and past letter-files, suppliers, and, if necessary, reference libraries and books. By him it is classified, tabulated, graphed, or condensed, and filed or kept where reference to it can be made with maximum ease by the buyer and his chief assistant.

Statistical Clerk's Work.

First of all, it is important to bear in mind that this assistant's work depends for its success upon its continuity. There must be no big gaps in the information he provides, because the absence of certain figures might be critical, leading to a false estimate that would seriously affect the buyer's work. From time to time, as is only natural, some of the information will get out of date, and have to be scrapped; but this does not mean that he should cease to supplant it by the current and accurate figures or facts. Prices, for example, are specially liable to lose currency, but at any moment it may be necessary to trace the increase or decrease in production costs between given dates, and then the absence of the prices ruling in the past would make it an exceptionally difficult and laborious procedure to arrive at this. One firm scrapped all its pre-war price records somewhere in 1921, only to find, a year or so later, that certain information in regard to these was essential. A clerk had to spend weeks, therefore, in turning up old order books, page by page, to extract the necessary particulars and important matters were delayed pending his completion of the task.

The maintenance of statistics is the work of a special "clerk;" but remarks in previous articles must not be forgotten. If the size and importance of the buying department warrant it, it may be necessary to employ more than one member of the staff on this work. How many can be decided only by special circumstances. In the compilation of data, the part played by the buyer himself must not be forgotten. When he visits supplying firms, he should do his best to obtain from them trustworthy details of future outputs, improvements in design or method of manufacture, and so forth. Much of this information he will have to memorise; but it none the less constitutes an important part of the purchasing data indispensable to his work. To indicate with the greatest clearness the way in which the purchasing statistics should be handled, it will be as well, where separate analysis is needed, to discuss one or two of these classes, as enumerated at the beginning of this article.

Coal: Hards ..... Nuts ..... Slack..... | 1914 price. 24/- ton. 19/6. 6/- ton. Average 12 months' cons. 7,000 tons.

	Total.	Jan.	Feb.	March.	April.	May.	June.
Hards: Shytown	2,080	110	120	150	200	1,000	500
		25/-	*25/-*	*25/-*	*28/6*	*28/6*	*29/6*
Nuts: Norbury	1,000	200	300	200	150	100	50
		22/-	*22/-*	*22/-*	*22/-*	*24/6*	*24/6*
Slack: Various	60	10	10	10	10	20	—
		9/6	*9/6*	*11/-*	*11/-*	*11/6*	*11/6*
Monthly Total	3,651	370	530	510	470	1,210	561

Fig. 1.—Buying Department Statistical Card.

Position of Single Contract.

Name of firm.....

Address .....

Date.	Order No.	Price.	Terms.	Contract Quantity.	Deliveries.	Quantity to deliver.
				T. c. q. l.	T. c. q. l.	T. c. q. l.

Description. | Delivery.

Fig. 2.—Card Showing Position of Single Contracts.

The Extent and Character of Former Purchases.

In some foundry buying departments the plan is followed of combining this information with that included in other sections. Thus, if brief details of each order sent out are kept on cards, means are found of recording on the self-same cards facts about prices, aggregates, and so forth. For example, the illustration, Fig. 1 shows a statistical card in use in one buying department.

The figures given in this illustration are fictitious, but, as will be seen, the record shows the consumption of a particular commodity or raw material from month to month, and also the fluctuations in price over the same period. Prices are inserted in red ink, so as not to be confused with weights when adding up the vertical columns. At the foot is totalled the aggregate for each month. In the instance given, that of coal, the commodity is divisible into three classes: hards, nuts and slack. The card shows the monthly consumption of each of these classes, and the prices paid. It also shows at the foot the total of all three classes consumed in the corresponding period. At the head are given the 1914 or pre-war prices for each class, and also the average twelve-months' consumption for the preceding year. By means of these cards a series of graphs can readily be compiled for use and reference as required.

This is quite a good method of condensing and presenting a number of different classes of information in regard to a single commodity; but the criticism brought against it by those who have made a special study of purchasing data is its complication of figures, and its failure to present at a glance the desired particulars, charts based on the cards being necessary before their full value can be obtained. Furthermore, it gives no clue to the value of the total or individual purchases.

Many firms, however, do not record their purchases even as accurately and systematically as this, and do not possess the remotest idea of the aggregate amounts of any given commodity they order from year to year, or from month to month. Instead, they merely send out orders haphazardly as stocks decrease. In these firms' minds, system is merely a waste of time, and records unnecessary. It never seems to occur to them that by knowing how much of certain goods they use or need in a given period, they can buy more advantageously and efficiently.

Fig. 2 shows how single contracts can be efficiently and simply recorded in such a way as to facilitate reference. On the card is recorded the name and address of the supplying firm; the date and reference number of the order; the price and the terms, such as "carriage paid," "free our sidings," f.o.b., c.i.f.; the contract quantity; the deliveries as made; and the balance left undelivered. The space at the foot carries the alphabetical classification of the material contracted for, and the cards are filed in the horizontal trays under the visible system described in a previous article. Each card is visible, and can be turned up in a second.

It is announced that the directors of the Yorkshire Electric Power Company are arranging that the Ferrybridge Power Station will be on view for inspection of the first section, which is now completed. Invitations have been sent to power users, local authorities, local Chambers of Commerce, etc., in the company's area, for October 18, 19 and 21. October 20 and 22 have been reserved for shareholders. The first section of the station includes two 19,000-kw. turbo-generators with the necessary boiler plant and auxiliary machinery. The ultimate capacity of the station will be not less than 180,000 kw. The site is an ideal one for supplying the needs of the West Riding, and the station will form an important link in the national electricity scheme. An exhibition of industrial electrical appliances in operation will be an interesting feature.

The Influence of Alumina on the Casting Properties of Aluminium.*

By F. Renaud.

While the term aluminium was used in his Paper, M. Renaud explained that it was his intention to discuss more particularly alloys containing a high percentage of aluminium, such as 92.8, which was the commonest of all the copper alloys, and was known in England as No. 12 alloy. It was to this that most of his observations would apply.

General Considerations.

It had long been observed that cast aluminium was covered with a fine film of oxide. When the metal was poured on the floor or into an open sand mould one had the very clear impression that the metal was passing through a sheath of alumina which it tore and distorted. The metal appeared to "roll" inside an envelope.

All aluminium founders had noticed that when the metal was poured a kind of tube of alumina surrounding the stream of metal was produced at the lip of the ladle. When the ladle was tipped an actual hose was very clearly seen, which, swollen at first, became contracted and then hung at the lip of the ladle.

In the neighbourhood of the gate it was easy to note traces of a film of alumina which spoiled the surface appearance. This film played a protective part: immediately it was formed it prevented further oxidation. It could readily be understood that the greater the specific surface of the metal the greater were its chances of becoming oxidised. This was why it was necessary to avoid decanting, the stirring of baths, and violence in pouring.

It had been stated by M. de Fleury that this sheath was subject to considerable surface tension and that its introduction into the liquid by entrainment diminishes the fluidity, It was an equally noteworthy fact that reclaimed metal, metal obtained from scrap frequently remelted or from an over-stirred bath, had very inferior fluidity and casting qualities.

In view of the foregoing it seemed desirable to emphasise the following fact: Although from the chemical point of view there was only one kind of alumina, there were two kinds from the physical point of view. There was that which might be described as "nascent alumina," viz., that formed instantaneously on all the naked surfaces of the metal. Its action was generally seen in surface phenomena, such as difficulty in uniting two streams, difficulty in obtaining acute angles, etc. The other kind might be termed "occluded alumina." It is the former type which has been incorporated in the liquid by entrainment. Its action affected the casting qualities (life) and most certainly influenced the structure.

Occluded Alumina.

This was the surface alumina which by entrainment or emulsion became incorporated in the metal. A question at once arose: Was alumina soluble in metallic aluminium? So far it had been impossible to decide it, for experimenters making scientific researches on the subject were not yet agreed. Rhodin, Guillet and Anderson said that alumina was insoluble in aluminium, while Rosenhain and Grogan declared that it was soluble.

It was difficult to decide the question, as Mr. Portevin stated that microscopic examination had not yet revealed the alumina (1), but that chemical analysis gave positive results (2). The "aéronautique française," on the other hand, had specified a maximum alumina content for each quality of aluminium (3). In the speaker's opinion, to observe the poor casting properties of reclaimed metal or metal that had been too much stirred was sufficient to convince one that the alumina remained incorporated in the metal in the form of filaments and films. If the alumina was soluble it was certainly so only partially.

It was this kind of alumina that he had termed "occluded alumina." It originated from the oxidation of the surfaces of remelted scrap or of parts brought into contact with the air by stirring or mixing. It was analogous to the film of cream formed on milk which, after being stirred or poured, was incorporated in the liquid. It had been proposed to decant this alumina. M. de Fleury appeared to recommend this method (sullage basins), and so did M. Lemoine (4) by means of a centrifugation basin. These methods did not appear to him suitable. The difference in density of alumina and aluminium was very slight (5), and it was, moreover, difficult to know whether decantation had taken place, as the law

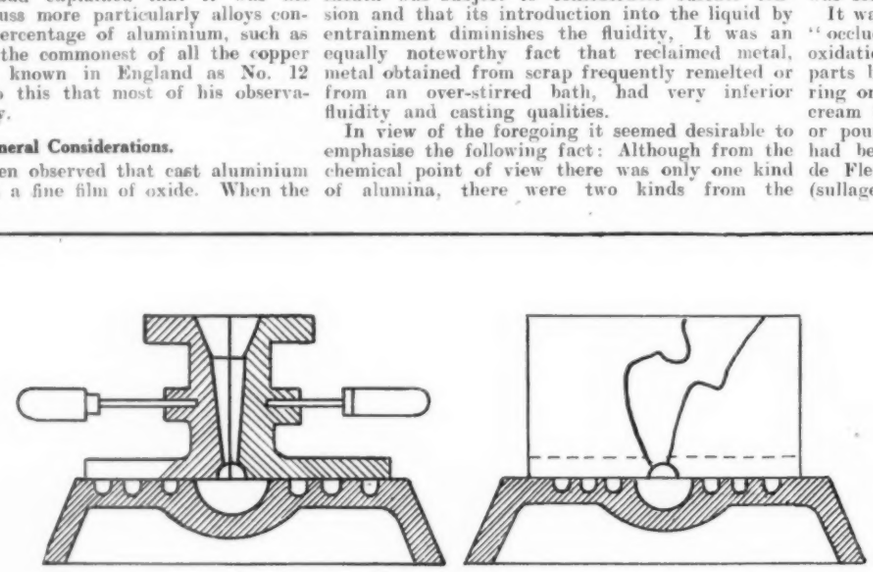


FIG 1.

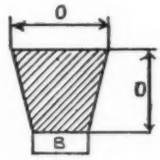


FIG 2.

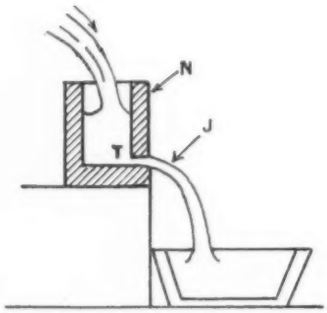


FIG 3.

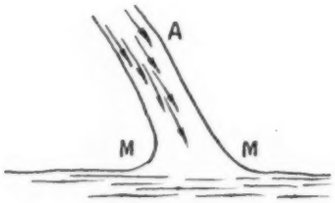


FIG 4.

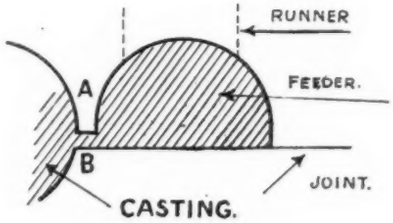


FIG 5.

* Translated from the Bulletin of the Association Technique de Fonderie.

(1) Anderson observes that no evidence of alumina has been obtained with the microscope, but that it has been proved chemically.

(2) The method of Nicholardon. (A current of chlorine through the sample and the estimation of alumina as aluminium chloride in the chloride state.

(3) Anderson draws attention to the fact that it is only in France that the expression "alumina content" is used, and that the specifications of the "aéronautique française" are as follows:—

Quality.	Permissible content.
Al of 99.5	0.4 per cent.
Al of 99 to 99.5	0.6 per cent.
Al of 98 to 99	0.8 per cent.

(4) Cours de l'Ecole Supérieure de Fonderie (copper alloys).

(5) A. G. Lobley gives the density of aluminium as 2.7 and that of alumina as 3.85 to 4. Lobley says: "When the oxide has penetrated to the interior of the metal there appears to be no means of eliminating it. It is difficult, in fact, to separate the metal from the oxide gravimetrically owing to their slight difference in density."

of Stokes (6), which gave the speed of decantation, applied to substances in the form of perceptibly spherical particles, and not to films such as were certainly present in this case.

He had sought to give some idea of the influence of alumina on the casting properties of the metal. He had, he said, definitely found that in hearths where materials consisting of the same lots or of the same origin were used it was impossible, when evening came, to obtain good casting test pieces with the metal remaining in the bottoms. He worked with furnaces with a fixed bottom and natural draught. When it had to be cast the metal was taken up in large spoons and decanted into the ladles. In the evening, therefore, there remained a certain quantity of aluminium which had been considerably stirred and was consequently highly oxidised internally.

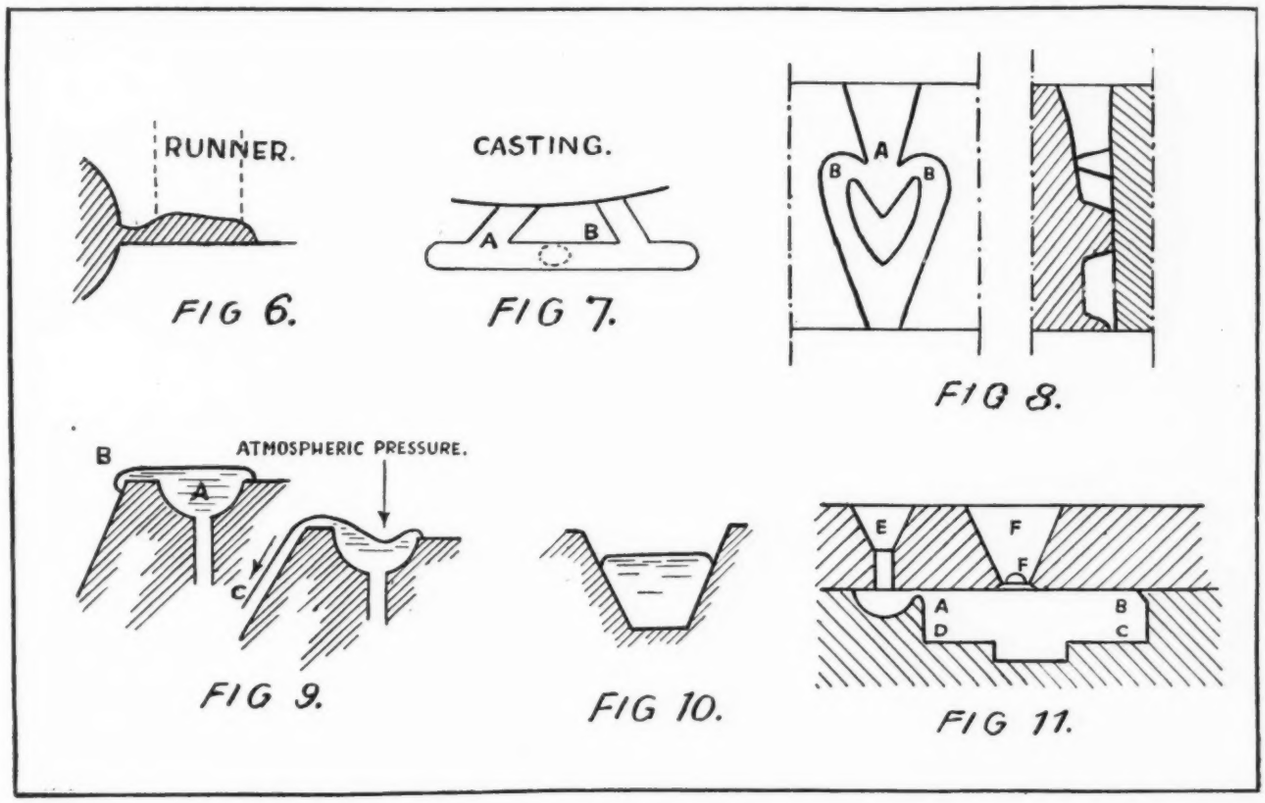
The test pieces obtained in the evening had 3 to 5 divisions, while those taken during the day had 10 or even 11 divisions. The "life" test pieces were obtained in a chill mould, a diagram

The following method was followed:—The sole of the chill mould and the parts containing the runners were heated at the side of the furnace, and a certain number of test pieces were cast at determined intervals, so that there was equilibrium between the heat radiated by the mould and that produced by the metal of the test pieces. The results already outlined applied to the test pieces showing the best length in the cases in question. These tests, he admitted, ought to have been made with exact measurements of the mould and gates, but he had not the necessary apparatus available. The differences, however, were so striking that the conclusions were obvious. All aluminium founders, moreover, must have observed the difficulty in obtaining sound and successful castings from the bottoms of pans, even though the materials were of the same origin, and therefore essentially of the same composition, so that it might be concluded that the differences were caused by the oxide content.

In view of this cause of poor casting properties terminology must have arisen from the fact that the workman, when dealing with viscous metal, endeavoured—unsuccessfully, however—to raise his temperature (no doubt excessively) for the purpose of restoring fluidity.

In order to avoid the production of oxidised metal, he would recommend that aluminium turnings showing a very large specific surface of oxidation should be used only with precaution. The stirring of baths and violent mixing should also be avoided. Casters using chill moulds were too much inclined to drop the metal from a great height into their bath, which produced a veritable emulsion of alumina in the liquid metal. Frequently this alumina even entrained air and formed bubbles, which were doubtless more detrimental than the alumina itself.

The results of these observations were as follows:—It was obviously essential to prevent this "occluded alumina" being introduced into the moulds. Three methods were recommended for keeping back the alumina: (1) Cullage basins; (2)



of which was given in Fig. 1. The plane of the spiral was that given by his colleague C. Cury, the divisions being numbered every 5 centimetres; the form of the gate was also that given by him.[7] With the chill mould this enabled the dynamic effect of the pouring to be eliminated. For obvious reasons no filter had been inserted, as the object was to study the influence of the alumina in suspension. For the same reason the changes of direction in the form of the gate had not been exaggerated. He had ventured to modify the section of the spiral, thinking that as the alumina was more viscous than the metal he might increase the section so as to obtain longer and, therefore, more comparable test pieces. He had adopted the dimensions shown in Fig. 2. It would be seen later that the surface alumina would have exercised an influence if the section as indicated by Cury had been retained.

(6) The law of Stokes: $V = \frac{K\ (ds - dl)}{N} \times r2$.

V = speed of decantation.
K and N = coefficients.
ds = density of the solid.
dl = density of the liquid.
r = radius of curvature of the solid particles.

(7) See last week's issue of The Foundry Trade Journal.

it was important that attention should be directed to occluded alumina, which certainly exercised a very detrimental effect on the mechanical properties of the metal. A "life" test-piece would be of the greatest service in alloys containing a high percentage of aluminium—greater than in any other branch of foundry work. The results given by it would be very closely related to the alumina content. In regard to two lots showing the same analysis the difference in the results of the "life" tests might be stated to be proportionate to the respective contents in alumina. The interest of these estimates was all the greater inasmuch as it was very difficult to determine alumina.

Workmen, and particularly metallic mould workers, knew very well the importance of viscosity in an oxidised metal, for which reason they did not like working with a bath containing any considerable proportion of reclaimed metal. In foundry parlance, a metal was often said to be "scorched" or "burned." It would seem more logical, in view of what had been said, to try to substitute the term "oxidised." The former implied an excessive increase in temperature, whereas oxidation might often take place in the absence of such a high temperature. The error in

changes of direction of flow, and (3) filtering. It did not appear that the first method was very suitable, since the separation could not be effected gravimetrically. Nor did centrifugation appear any more efficacious because, in his opinion, the alumina was in the form of a film. The second method appeared more logical; the alumina was held by the corners where the direction of flow was changed if they were sufficiently sharp. This method was employed, as far as possible, in the works where his observations had been carried out. The third process, of which M. de Fleury discountenanced the use, appeared to him to give good results. It was applied with great success on a large scale in the works he had mentioned. He would now endeavour to justify it.

Filtering.

The restriction of section due to the process of filtration obviously increased the oxidisable surface, but this process, while augmenting within certain limits the "nascent alumina," was certainly very efficacious in keeping back the alumina and impurities incorporated in the interior of the metal, and it would be seen presently that the first appeared less troublesome than the other.

Filtering, however it was effected, enabled the gates to be kept full and the pouring to be carried out with a uniform flow; if "t" seconds were required to fill a mould, "t" seconds would be required to fill a similar mould. The effect of the personal factor was thus suppressed, and the value of this result must not be under-estimated in regular production.

The following fact, moreover, had been observed: If in a hollow core N (Fig. 3) a hole T was pierced, and if this core was filled with aluminium, it was found, if the core was kept full, that in T there was formed a stream of metal J having a constant radius of curvature, that this metal was enclosed by a virtual tube of alumina, and that it flowed in the interior of this sheath as indicated in Fig. 4. If one watched a moulder who was filling a small mould regularly and fairly slowly, they would see the stream of metal passing from the ladle to the mould, but at certain moments the movement of the metal was invisible. When the moulder tipped up the ladle a sort of hose was observed, which closed up and hung from the ladle. It would, therefore, be a mistake to assume that the oxidisable surface is V if V is the volume of metal poured and P the total perimeter of the holes in the filter.

Theoretically, he thought there was no break of continuity between the alumina in the tube A and the alumina on the surface of the bath. If such break existed there would be at M (Fig. 4) an annular portion where the metal would be exposed and as oxidation was instantaneous it would be oxidised. Moreover, the filter grate which he would recommend later could nearly always be placed in such a manner that there was liquid metal on either side of the filter section. There was, therefore, no occasion to bring in the oxidisable surface. It was likewise erroneous to maintain that a restricted section necessitated very hot pouring. It was enough to place in front of that section a part which he had termed a "sow" (nourrice), the function of which was that of a "heat pole" as understood by M. de Fleury.

Types of Gate Recommended.

For all the reasons already given the form of gate recommended was that shown in Fig. 5. The section AB was made as small as possible so as to flatten and filter the metal and to stop the alumina films, but without affecting stoppages due to any changes of direction provided. The section AB was followed, at as short a distance as possible, by a massive part which served to heat the thin part AB. For this part, which he had termed "nourrice" (sow, or feeder), a form as nearly as possible cylindrical was recommended, so as to obtain the minimum cooling and oxidation surface for a given volume. This mass would keep the metal fluid in the neighbourhood of the filter section, and would maintain for a considerable time the effect of the static pressure due to the height of the metal in the gate. This effect was of great importance in obtaining successful aluminium castings. It was too frequently neglected on the pretext that aluminium was a material of low density.

In any case, runners of the type shown in Fig. 6, such as certain moulders sometimes employed, ought to be avoided. The gate shown in Fig. 5 was equally suitable for sand and metallic mould castings. As regards the ground plan of the gates, the form shown in Fig. 7 was recommended for sand, with very sharp changes of direction at A and B. For metal moulds the form indicated in Fig. 8, with two sharp changes of direction at A and B, was recommended. This type of gate, which could easily be introduced in copes, had not been tested. It might, however, be used successfully in cases where the alumina film observed on castings would spoil the appearance of a fine casting. In addition to the advantage of filtration in itself there was also that of regularising the pouring, a constant flow being obtained. This advantage could not be over-emphasised as it enabled a man without special training to be put in charge of the casting. All that was then required was to start pouring and keep the gate full.

NASCENT ALUMINA.

By "nascent alumina" was simply meant the "alumina" generally implied when that term was used. On a bath of molten aluminium there was found a dull coating of oxide. If it was removed the metal was seen to be brilliant for a very brief instant. A fresh coating of oxide was then formed instantaneously. This was what he had termed "nascent alumina." If the influence of this alumina were considered it might be said at once that, in his opinion, its effects were much less important than those of the alumina incorporated in the interior of the metal. It was chiefly detrimental to the good appearance of the castings.

From the mechanical point of view the properties of the metal cast were certainly not affected by this film, the thickness of which was perhaps from 1-20th to 1-50th of a millimetre. The film, however, might prove troublesome because it retained air or gas bubbles in the immediate neighbourhood of the soiled surfaces. This fact might prove inconvenient in certain cases. For example, he had had to cast certain plates which had to have a polished surface; after casting their appearance was normal, but after being polished the plates showed a pitted surface in the neighbourhood of the gates. This defect was easily remedied by altering the gates. These films became troublesome because they became incorporated in the interior of the metal and there formed the first kind of alumina (occluded). This alumina film impeded uniting when the flow through the mould was too long (in different directions), and particularly after a long passage between narrow walls.

Surface Phenomena.

If the metal bath was not stirred or agitated there was no reason, he thought, why the alumina should not remain on the surface. An analogy might be seen in a thin sheet of paper large enough to be placed on the surface of the water in any kind of container. Anderson had said that alumina which is not moistened by the aluminium remains on the surface. Of that he was convinced. The viscosity of the metal and the surface tension of the alumina contributed in keeping the latter on the surface. The tenacity of the alumina, due to its high surface tension, had been proved by the celebrated experiment of Skinner and Chubb. A thin aluminium wire, through which an electric current capable of melting it was passed, was immediately covered with a coating of alumina which sufficed to prevent the resistance from breaking, with the result that the current continued to flow, the molten metal being held in a sheath of alumina which did not break. This was the reason why the use of thin aluminium wire for fuses had been discontinued.

He would now give an account of a curious phenomenon which he had had occasion to observe. While pouring the alloy into a gate A, arranged as shown in Fig. 9, it was found that when the aluminium overflowed ever so little at B the part D became hollow, while the metal flowed at C, which proved that the phenomenon in question was a striking instance of siphonage, the alumina surrounding the channel C acting as a tube.

The surface tension of the aluminium due to the alumina was very detrimental to the success of castings, particularly in metal moulds. This surface tension of the envelope frequently led to talk of viscosity, but the fact could not be sufficiently emphasised that real viscosity was determined only in the mass of the liquid, while in the case under examination the phenomenon was only superficial. For this reason the "life" test recommended for internal alumina did not appear to be necessary in this case. The casting properties, in fact, ought to be much more a function of the viscosity than of the surface tension. Alumina being a chemical compound, with a well-defined formula, and its surface thickness being nearly the same in all cases (it was known, in fact, that when formed the alumina film prevented deeper oxidation), the casting tests for materials of the same composition ought not to give such different results if the casting properties depended on the surface tension.

The molten aluminium entering a mould might analogously be represented by water flowing in an envelope or membrance of rubber, similar to that of a child's toy balloon. It could readily be conceived that such a system would in certain cases have difficulty in conforming to all the involved outlines of the vessel which had to contain it.

The Mechanism of Mould Filling.

If aluminium were poured into an ingot mould (Fig. 10) it would be observed that the point of connection between the upper surface of the ingot and the lateral walls was rounded off for about 4 to 6 mm. The same phenomenon was evidently produced in a mould. It was due to the surface tension of the alumina, and was explained by the analogy that had been cited. Let them take a mould such as that sketched in Fig. 11. The casting ABCD was poured at E. At F, for one reason or another, there was a feeding riser. This term was used because in casting aluminium an opening of this kind often served as riser and feeder. In order to get the metal to conform to the edge B it was necessary that this rounding off should be eliminated. It was necessary (1) to have a pressure of metal (height of metal above the plane AB; here was seen the influence of static action); (2) to prevent counter-pressure between the metal and the dihedral angle formed by the walls of the mould (joint with inclusions, porosity, blowholes, etc.). It had frequently been found that when there was a feeding riser, parts such as B (Fig. 10) turned out badly. This fact was somewhat anomalous, for immediately the level rose above AB the pressure which caused the metal to rise in the riser was less than that which ought to force the metal to conform to the corner B. This must be due to the fundamental postulate that the area of the contact surface of any two bodies (two gases excepted) tends to diminish (1). In other words, when one of the two bodies was sufficiently fluid, the surface tension operated, giving its surface its minimum value at constant volume. At the moment when the level of the liquid was at AB for the same elementary volume taken at F and at B, the surface which could be obtained at F was generally less than that obtainable at B; this could be asserted, as on the liquid reaching AB the pressure was the same everywhere. (It was at first zero and increased everywhere in the same degree immediately the level rose in the gate).

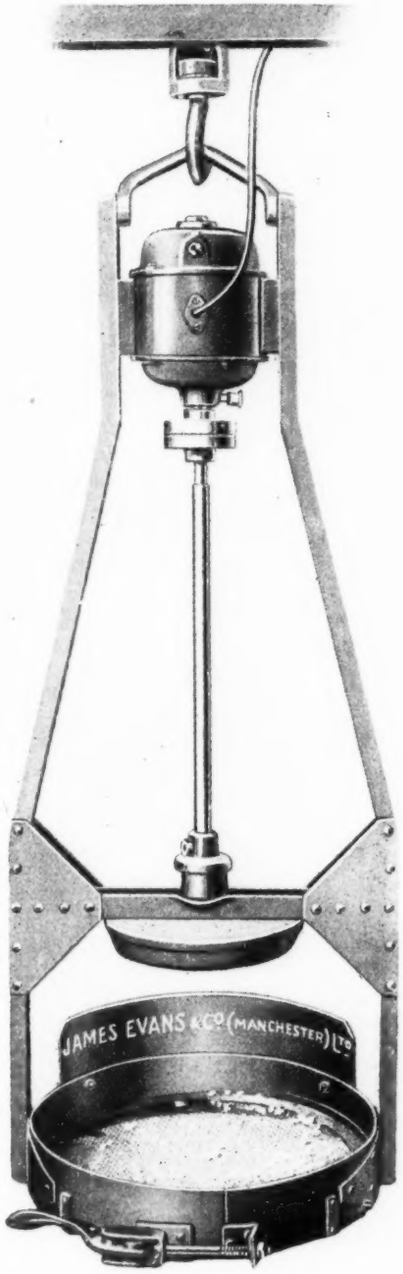
In all cases such as are represented by Fig. 11, the part B had been in contact with cooling surfaces longer than the upper surface. Owing to this cooling, the alumina was rendered tougher. It might also be said that at the moment of pouring a species of suction was produced in the feeding riser, which prevented static pressure from taking place freely at B. When it ultimately took place, the part B had been cooled a little more and was consequently less elastic. It was, therefore, a question of the rate of pouring and cooling. It might be added that at points such as B there always existed a counter-pressure due to the air imprisoned in the angle, but this counter-pressure was clearly not present in the feeding riser.

(1) This postulate is found in works treating on capillarity.

In view of all the foregoing, he was led to conclude that it would be beneficial, from the point of view of obtaining successful castings (and only for this reason), to suppress the feeding riser and to substitute for their action one of the known methods, viz.: (1) Venting; (2) chills (for sand casting); (3) cooled prods (broches, refoidés); (4) water cooling (for chill casting), and others which need not then be mentioned. In foundries doing metal mould castings it was a common belief that a large number of gates favoured the production of good castings, but they were frequently troublesome for the reasons that had been indicated.[*] When because of total contraction it was impossible to do away with an open riser which caused the defect which had just been outlined, it was advisable to employ a "blind" riser of slight depth, in which case static pressure was quickly established, without appreciable delay. This arrangement was particularly easy to effect in metal moulds, and it had already been tried with success.

(*) See works treating of die casting, particularly that of Mortimer. Proceedings of the Institute of Metals and Institute of British Foundrymen.

EVANS'S ELECTRIC
GYRATORY FOUNDRY RIDDLE



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A Review of Foundry Practice.

North-East Coast Conditions Reviewed.

At the opening meeting of the Middlesbrough Branch of the Institute of British Foundrymen, held on September 23, Mr. Fred P. Wilson, who has been re-elected as President for a second term of office, delivered his Presidential address, in the course of which he said:—

Gentlemen,

The syllabus of papers for the session expresses the desire of the Branch Council to cover as many aspects of the Industry as can be compassed in six meetings. The titles of these Papers, together with other subjects arising from them, or occurring to anyone interested in the work and outlook of the foundryman, have suggested to me that I might very briefly touch on some of the many topics in which we are or ought to be concerned.

When one enumerates the headings in this way, one very soon realises how wide is the scope of the foundry industry.

The foundry industry in this country was for long years very much in the hands of the inconspicuous individual, a craftsman himself, possessed of small capital, but enough to set up a piece of old boiler tube in a shed in his backyard, blow some air into it by some primitive means, charge it up with the cheap and common domestic scrap collected in the neighbourhood, and proceed to mould and cast articles of everyday use.

Overhead charges hardly concerned him as long as he could pay rent and rates. General labour was probably provided by his family, including, no doubt, his wife, and so the business kept him alive and his sons followed on in a sort of hereditary industry.

Many such foundries still exist in the bye-streets of our large towns, but, perhaps, in the malleable casting trade of the midlands they are now most common.

Engineering Developments Require Better Castings.

With the industrial revolution of the late 18th and early 19th centuries the demand, first for textile machinery, and later for steam engines, railways and industrial machinery of all kinds, calling for castings of heavier and more intricate design, and at the same time better material, naturally led to the development of the foundry trade. The engineer was called in to consider blowing, lifting and handling appliances, and his brains have been at work ever since in these and many other directions.

The apparent simplicity of mere melting metals, moulding simple forms and casting, in the early days was no doubt responsible for the fact that for so long the foundry trade was looked upon as an unpleasant, dirty, but necessary evil in the engineering trade.

For convenience sake, the engine-builder set up his own foundry as cheaply as he could, and as long as it produced the castings he wanted, when he wanted them, he was not interested in the methods of production, and cared little about the costs. In fact, he tried, perhaps unconsciously, to forget the very existence of the moulding shop. But civilisation was not standing still, and the engineer was not the only person who could find a ready use for castings, and many specialised branches of the trade grew up.

Light Castings.

Light castings for domestic purposes must have come early. With the rapid growth of the population, and the need for houses, there would come the demand for rain-water pipes and gutters, stove grates and mantelpieces, cooking vessels, and probably, by very slow degrees, even baths.

For some reason this trade seems to have settled down in the lowlands of Scotland. It may have been that the far-sighted gun-founders of Carron saw the end of the demand for cast-iron cannon approaching and looked for a new outlet. However, the light-casting trade certainly caught on in this district.

On the other hand, Tees-side has never seemed to be attracted by this type of founding, though Messrs. Crosthwaites, of Thornaby Foundry, certainly possess a very modern and well-organised light-castings foundry, and there are one or two others in the district.

Pipe Founding.

The rapid development of large towns naturally led also to the need for adequate water supplies and better drainage, and thus the pipe-founding industry came into its own. The great variety in sizes and sections of pipes resulted, of course, in some specialisation as between light and heavy types, and both are represented in this district.

There has been much thought and skill devoted to improvements in methods of pipe moulding, and a large amount of capital has been laid out in special plant for facilitating the vertical casting of large pipes. The latest development, centrifugal casting, has opened up a new field which promises great things.

Railway Castings.

The growth of railways again, when cast-iron rails, having become unsuitable for the increasing loads and speeds, gave place to steel rails, set up a demand for a cast-iron chair, and this having grown from a small jobbing casting weighing about 25 lbs. to a standardised article of 45 to 50 lbs., has found repetition work for several large foundries.

The chair founder of 40 years ago would hardly recognise the modern chair, which, though moulded on the simplest type of machine and hand-rammed, has to be made to such close limits as to dimensions and weight and pass such exacting tests, that from the finish of the metal patterns to the fitting of the box pins, and from the weight of the chair-rammer stroke, to the accuracy of the chemist's determination of the constituents of the metal and coke, the closest supervision is constantly demanded.

This industry, though not confined to any one area, has found a congenial home on the N.E. Coast, where materials are easily available and shipping facilities abound for coastwise and foreign delivery. Unfortunately, the railway development of this country has reached something of a pause, and our foreign Possessions are doing more for themselves, so that the large available capacity of our chair foundries is hardly likely ever to be fully occupied again. Moreover, some of our railway companies have a weakness for trying to supply their own requirements, and one has heard of one of our largest systems still producing chairs as jobbing castings, regardless of the extraordinary cheapness at which they can be bought from competitive foundries.

A further development of the ordinary chair is the bowl, or so-called pot-sleeper, used mainly in hot climates, where the ballast is loose and the white ant devotes so much attention to wood sleepers. These sleepers, weighing up to about 112 lbs., are made in the chair foundries, and require very accurate patterns and tackle, but in their case also the demand is diminishing through the Indian foundries having learned to make them from the local materials.

Other Industries.

There remain innumerable types of casting of constantly changing shapes required to meet the rapidly-developing demands of the engineering and industrial world, and as the demand varies, so have the foundry-plant designers constantly sought to devise machinery to displace hand-moulding and increase accuracy and speed of production.

Moulding Machines.

There is to be a Paper on machine moulding this session, so it is only needful at the moment to name the more prominent methods, such as turn-over, hydraulic pressing, pneumatic or electric jolting, sand-slinging and pipe-spinning.

We shall never displace the skilled moulder entirely, nor should we wish to see so able a craftsman disappear, but inevitably the demand for increased output and reduced cost will compel the founder to use machinery wherever possible, but, of course, with the idea of more specialisation. He must decide on the general lines of his productions, and instal the appropriate machinery, otherwise he may find his shop looking like a machinery exhibition, and with never more than a small proportion of his machines occupied.

Core Making.

Along with moulding-machine development has come similar progress in core making. Accuracy in size, strength to stand the pressure of metal, capacity to withstand heat, the production of a smooth skin, and the facility for falling into dust at the tap of a hammer on the casting, are all ideals to aim at, and hence the extreme care that is now taken in the best foundries in the selection of suitable sands, the sorting out from the numberless oils, gums and binders of the one best adapted for each particular purpose, the setting up of sand-drying and core-sand-mixing machinery, the use where possible of coremoulding machinery, and finally, the selection of the right drying stove.

It would be possible for the foundry manager of an engineering turn of mind to spend some days in merely listening to the recital of the respective advantages of each of the materials and appliances covered in this list, and offered by their respective enterprising salesmen, and when all that has been done, he has only touched the *core-shop*, the section which was formerly looked upon as the most disreputable part of an objectionable department!

Cupola Developments

The cupola was for long a much neglected appliance. It was only asked to melt the pig-iron and scrap put in, and small notice was taken of the fuel consumed, or the power absorbed in blowing.

The proportions of surface area to shaft area, the depth of bed-coke, pressure and volume of blast, and the machinery for producing the blast have all now been scientifically examined, and are constantly being watched and recorded. Again, there is to be a Paper bearing on cupola design, where finality has probably not yet been reached.

Incidentally it is interesting to note the revival of the plan of an ascending spiral of small tuyères round the shell, in a recent foreign design, to complete combustion of CO, as it recalls the Greiner and Erz method which some of us remember more than 30 years ago.

Raw Materials.

The charging of the cupola has produced many interesting devices for reducing hand labour, and in this direction standardisation is impossible, and each foundry manager must work out his own salvation in accordance with the lay-out of his plant. The same applies to the stock-bins for metal and scrap. The pig-iron of to-day is a very different material from that of a generation ago. Our fathers bought a recognised brand and grade, and that was all there was to it. The sampling was entirely by fracture, and the results were sufficiently uniform to produce castings which met the requirements of the engineer of that day.

But both pig-iron and engineer have changed; one has become less reliable and the other more exacting, and hence we have called in the chemist. In working to modern specifications and tests it is needful to analyse every truck of pig, and burden the cupola in accordance with the results, thus calling for much more knowledge on the part of the manager, more care in recording charges and resultant mixtures, and considerably higher intelligence on the part of foremen.

Apprentice Scarcity.

It is recognised that apprentices for the trade are becoming harder to get. This is partly due to the development of machine moulding and the displacement of skilled labour, but at the same time the scientific trend referred to above makes it more than ever essential that the lad who enters the trade with an ambition to rise to a foreman's or manager's job should have opportunities for some technical, and at least a rudimentary scientific, training. Even moulding sand is worthy of

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chemical and physical research, and the Secretary, Mr. N. Ridsdale, is to give us the results of his own investigations into this subject during the session.

Fresh sand quarries are opened up from time to time, and it is important that we should be in a position to decide on relative values of different sands, in regard to cost and efficiency, and foremen and moulders should be encouraged to interest themselves in the functions of the sands they use.

In the moulding shop, the question of cranes and mechanical handling of materials and products is another matter of great importance, and we are looking forward to an interesting Paper on this subject in March.

Pattern Making.

I have not referred to the very foundation of the trade, the pattern shop, as it worthily claims a Paper and discussion to itself, and this we are to have very shortly, and it is another case where the mechanical engineer is constantly devising specialised machines for producing highly-accurate patterns at low cost compared with skilled hand labour.

Even in so incomplete a survey of the foundry trade as this, some mention should be made of other branches than those already discussed. The malleable castings industry is highly important, probably increasingly so, but though well established in the Midlands, has never found a place on the North-East Coast. It would be interesting to know why this is so, as I have never been able to get a satisfactory explanation. It may have something to do with the small hereditary shops referred to earlier, and which are much older industrially than our area, but that does not explain why no Birmingham man has ever thought it worth while to emigrate to Tees-side and there set up a malleable foundry.

The Steel Foundry Industry.

In many ways—machine moulding, repetition work, mould drying, core making, handling, etc.—the general principles are the same in the steel foundry as in the iron foundry. Steel-converting and the electric furnace are of course another story, and reference might also be made to electric-welding, sand-blasting, pneumatic chisels, and many more appliances, but it must suffice to say that on the N.E. Coast the steel founding trade is very worthily represented.

In the foregoing remarks I have tried to show something of the variety and complexity of plant and operations affecting the trade from its technical side. There remains something to be said on the commercial aspect.

Costing.

As long as the foundry was merely the despised adjunct of the engineering shop no one cared particularly about accurate costing, and one fears that as foundries came to be set up for the main purpose of supplying castings for the market a legacy of careless costing was handed on. The extraordinary era of competition and price-cutting during recent years has, however, done something towards waking up the owner and manager to look for some accurate method of assessing costs, allocating on-costs and overhead charges correctly, and thus finding a safe way of preparing estimates for new work.

It is strange, but true, that there should be people who still think that the same overhead charge per ton should be debited to a job weighing 1 cwt. as to another weighing 1 ton, and occupying the floor, the core bench, the stores and the cranes perhaps ten times as long.

The old rule-of-thumb method of looking at a drawing or pattern and guessing at its cost may bring off an order and may make a profit, but more probably it will make a loss, which loss may at the same time be buried in the profits of more successful jobs, or may even swamp them entirely.

It should be, and is, possible to cost every job correctly as soon as it is finished, and similarly to estimate accurately for new work, and those foundries where such methods are insisted on will win through in the end.

I believe in America a standard costing system for foundries has been evolved by experts, as has been done in some other trades in this country, and one may devoutly hope that something of the kind may some time be attempted here in our trade.

It is probably true that the average foreman and most moulders have very little idea as to the actual cost of jobs apart from wages.

Your Council have considered this matter of such importance that they have asked Mr. A. W. G. Bagshawe to give us a paper on the subject, and I earnestly commend this to your interest as being of equal importance with the more technical subjects to be considered.

Conditions of Employment.

Payment by results in some form or other should be the rule wherever possible. If we are to encourage skill and increase output and thus cheapen production, we ought to let the workman who gives his best reap some benefit from it.

The law of the "survival of the fittest" which operates so generally in nature, except, of course, where man steps in with scientific methods of arresting the natural processes, operates in industry with unfailing regularity; that is to say, the business that cannot hold its own in the struggle for existence goes down, and it is not reasonable to expect that, if no premium is to be allotted to superior skill and efficiency on the part of the manual worker, but a flat rate be paid alike for good, bad and indifferent work, the industry can hope to survive. Fortunately of recent years our Trade Unions have relaxed their rules in regard to payment by results to a large extent. Straight piece-work can easily be adapted to a jobbing foundry, not so easily to a pattern shop.

In a repetition foundry, where men of several grades work together on the same job, it is possible to apply an output bonus scheme wherein every man has a direct interest in the combined output of the shop. This method is on the lines of the well-known "Priestman" system, and has been found satisfactory, not only in increasing output, but in developing a team spirit and removing petty internal friction, whilst the men, unconsciously perhaps, are learning how to find the greatest good for the greatest number. The more efficient man comes to realise that his superior skill does not work out only, or indeed in full, to his own benefit, but does something to raise the earnings of the whole shop and compensate for the less skilful work of the less efficient.

We cannot hope to hold our own in the fierce competition of modern times unless we have not only efficient plant and management, but the hearty co-operation of the workman.

It is unfortunate that the development of modern industry in the direction of large combines, run by boards of directors, often so far from the works that the respective *personnels* of the board room and the foundry are almost entire strangers to one another, has largely obliterated the old personal relationship of employer and employed.

It is true that under the old system the heart may sometimes have taken precedence of the head, and men have been kept on when their day of useful service had ended; but, after all, "man does not live by bread alone," and the friendly nod and smile will generally indicate not only a better spirit but better work than the clicking of heels followed by a scowl.

"Welfare work" has become a household word in industry during recent years, and it may take many forms, according to the local conditions.

The management that has a soul above merely extracting the utmost work at the smallest cost will find its own ways of showing concern for the welfare of its employees, always remembering that, though wisely administered it is no doubt a paying proposition; the last thing the employee wants is charity. Give him a little encouragement, if possible, by meeting some first costs of, say, recreation grounds or clubs, but leave him to carry them on. He will take a pride in showing how successfully he can run his organisations.

So many branches of science are concerned in our operations, engineering, metallurgy, physics, chemistry, economics, and what not, that we can fairly appeal to a wide circle of students, managers and tradesmen, and if anything I have said will inspire some of our members to go out into the foundries and compel others to come in, I shall feel abundantly repaid for my labours.

Artificial Lighting in Foundries.*

By W. H. Rademacher.

The efficiency with which many foundry operations are carried out depends to a large degree upon the workers' ability to see rapidly and accurately, and in semi-darkness it is impossible for him to do either. Production and quality suffer from poor lighting, and the accident risk is increased when vision is rendered difficult and uncertain.

Too much reliance cannot be placed upon daylight, and even under the best conditions certain parts of the foundry are practically always in need of artificial illumination, which, however, is essential for night work. Table I shows the recommended illumination in foot candles for the various foundry operations.

Table I.—Recommended Illumination.

Class of Work.	Foot Candles.
Charging furnaces	5
Floor-moulding and core-making	6
Bench-moulding and core-making	10
Casting, shaking out	5
Cleaning, chipping, tumbling	5
Annealing	5
Raw stock storage	1.5
Pattern store	3

Glaring lights in the field of vision of the workman should be avoided, since a workman looking at a glaring source is temporarily blinded, and until his vision recovers from the shock he is more liable to be accidentally injured or to make some serious mistake.

Experience has shown that for illuminating foundries, steel reflectors having a porcelain enamelled reflecting surface are the most satisfactory. These withstand corrosion very well. Equipment having aluminium or paint-finished reflecting surfaces should be avoided since these discolour and depreciate rapidly.

The fittings should be mounted overhead and arranged symmetrically so as to produce a uniform illumination over the entire working space.

A general overhead lighting system is more economical than the local or drop-cord method. In only a few exceptional cases should the latter method be adopted, and then only to supplement the general lighting. Inspecting deep and narrow moulds is an example of where it is imperative to use the drop-cord method. In such cases a fairly low power lamp fixed in a small deep-bowl steel reflector, so that direct light does not fall on the workman's eyes, should be used.

The smoky, dusty atmosphere of most foundries makes the question of the maintenance of lighting equipment particularly important, and the lamps and reflectors should be cleaned about once a month.

The American Bureau of Standards recently carried out a test on the cooling of liquid cast iron. They used a 75-ton closed truck ladle, and found that the rate of cooling was only 11 deg. per hour. Thus 40 hours would have to elapse before the metal became too cold to pour.

Fuel Conference, 1928.—At a meeting of the International Executive Council, World Power Conference, which was held at Gernobbio, North Italy, from September 5-10, 1927, each country was invited to submit to the British Committee a skeleton of each Paper they proposed to present for a preliminary exchange of views regarding the subject matter. The Paper itself would probably have to be written by an individual, but should receive the careful scrutiny of the representative body under whose authority it was to be issued, to the exclusion of all proprietary and specialised individual opinions. The desire of the British Committee to receive suggestions from all interested countries was emphasised, but as in some cases these may be of a conflicting character, it will be necessary for the British Committee to sift these suggestions before deciding, in consultation with other countries, what line of action should be adopted. The Conference is not to be a theoretical conference, but it is hoped that it will be of a thoroughly practical nature, based on sound technical lines directly related to practical economics.

* Abstract of Paper presented to the American National Founders' Association.

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(Part of) Aluminium Data Sheet A 121

Specification. No.	Specified Chemical Composition.[1]	Description.	Minimum Tensile Properties.[2] Ultimate tens. str. Tons sq. in.	Per cent. elongation in 2 in.
3L.11	*Copper* 6% to 8% *Tin* may be used up to 1% ...	Casting alloy	9	3
2L8	*Copper* 11% to 13% ...	Casting alloy	9	Nil
2L5	*Zinc* 12.5% to 14.5% *Copper* 2.5% to 3.0% ...	Casting alloy	11	3
L24	*Copper* 3.5% to 4.5% *Nickel* 1.8% to 2.3% *Magnesium* 1.2% to 1.7%	"Y" alloy castings	11	Nil

[1] In each of the above alloys the remainder consists of aluminium and normal impurities.
[2] Tensile tests for casting-alloys are made on specimens machined to .564 in. diameter from samples cast 1 in. diameter in a heated iron chill. Tensile tests for sheet are made on stamped specimens with width $\frac{3}{4}$ in. to $1\frac{1}{8}$ in., and parallel length $2\frac{1}{2}$ in.

F.T.J. 18/6/27.

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Trade Talk.

Hunton, Limited, have established offices and show rooms at Fitzroy Court, Tottenham Court Road, London, W.1.

The offices of the Electrical Association for Women have been changed to Palace Place, Kensington Court, London, W.8.

Crofts (Engineers), Limited, Thornbury, Bradford, have opened a new branch office at 14, New Street, Birmingham.

Guest, Keen, and Nettlefolds, Limited, Dowlais, are at present executing an order for about 24,000 tons of rails for the Egyptian State Railways.

The Cowpen Dry Docks and Shipbuilding Company, Limited, have booked orders for two steamers of 9,000 tons each from N.E. coast owners.

Meetings of the Manchester Section of the Society of Chemical Industry will be held at the Engineers' Club, 17, Albert Square, Manchester, during the session 1927-1928.

The Polish Ironmasters' Association has practically concluded negotiations for the purchase from the Soviet Union of iron ore from South Russia up to the value of about half a million sterling.

The German Bergius Company, of Heidelberg, the concern carrying on the Bergius process for the hydrogenation of coal, reports for 1926 a loss of 70,299 mks. as against a loss of 245,236 mks. in 1925.

Moon Brothers, engineers, etc., Beaufort Road, Birkenhead, have taken over the business of the F. E. Adams Pressure Tool Company, Limited. The company also own the Blakeney oil-burning system.

Among recent contracts the Wellman Bibby Company, Limited, have received repeat orders from Dorman Long & Company, Limited, and the Newcastle-upon-Tyne Electric Supply Company, Limited, for their patent air filters.

Mr. R. Williams, sole London agent for N. V. Dikema & Chabot's Trading Company, Limited, iron and steel stockholders, Rotterdam, has removed from 5, Lime Grove, Lewisham, S.E.13, to 22, Canadian Avenue, Catford, S.E.6.

The Blaenavon Company, Limited, have closed their offices at 104, Dock Street, Newport, Mon. All business hitherto transacted at Newport (other than coal, which will still be conducted from the Cardiff office) will be transferred to the head office at Blaenavon.

Prince and Princess Ri of Japan, who have been on a tour of this country, recently visited the East Hecla Works of Hadfields, Limited. In the absence of Sir Robert Hadfield, who was detained in London, they were greeted by Major A. B. H. Clerke and the other directors of the company.

Dorman, Long & Company, Limited, of Middlesbrough, have issued an official contradiction of a report that they have given instructions that men at the Port Clarence Works are to start two ten-hour shifts instead of the three eight-hour shifts fixed by the national agreement between the steel trade employers and trade unions.

A large magnet, capable of lifting five tons, is being used to salve the cargo of pig-iron of the steamer "Elterwater," which is stranded in the Firth of Forth, near North Berwick. Operations were begun a few days ago. A 220-volt magnet has been supplied by the General Electric Company, and the work is being carried out by the Leeds Salvage and Towage Company.

Intimation has been made to Mr. J. C. Bishop and Mr. O. Coyle, joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board, by Sir John M. MacLeod, Bart., to the effect that he has examined the employers' books for July and August, and has certified that the average net selling price brought out is £11 4s. 10.51d. This means that there will be a decrease in the wages of the workmen.

Automatic and Electric Furnaces, Limited, Elecfurn Works, 173 to 175, Farringdon Road, London, E.C.1, announce that their new works have been fitted with lifting equipment to deal with electric furnaces up to 6 tons in weight, and the most modern methods have been installed to deal with casemaking, etc. A large demonstration room, fitted with numerous types of electric furnaces, and adequate facilities for quenching the largest articles that are likely to be met with have also been installed.

A large casting has been despatched from the foundry of C. W. Taylor & Son, Laygate, South Shields, to the British Thomson-Houston Company, Rugby. The casting, which is for a turbine casing, took over eight weeks to complete, and its finished weight is 30 tons. More than 50 tons of metal were used in the casting, which is 17 ft. long, 12 ft. 9½ in. high, and 8 ft. wide. On its departure from the foundry the casting was mounted on a bogey specially built for C. W. Taylor & Son when they executed Government commissions for H.M. ships "Malaya," "Queen Elizabeth" and "Warspite."

An expenditure of nearly £300,000 on additions to their steamship fleet has been authorised by the directors of the Southern Railway, and four new vessels are to be delivered in time for next summer's traffic. A new twin-screw oil-burning vessel for the Newhaven-Dieppe service is under construction by Denny Brothers at Dumbarton. Two new passenger paddle steamers for the Portsmouth-Ryde (Isle of Wight) service are being built by the Caledon Shipbuilding and Engineering Company. A new cargo boat for the Dover-Folkestone service is being constructed by D. & W. Henderson & Company, Limited, of Meadowside, Glasgow.

An interesting British steel-making process, invented by Messrs. Hamilton & Evans, has recently been adopted by two of the largest German steelworks. As a result of a series of demonstrations, licences have been granted to Friedrich Krupp A.G., of Essen, and Vereinigte Stahlwerke A.G. (August Thyssen), of Hamborn, by the Stainless Iron & Alloys Company, Limited, of 14, Blackfriars Street, Manchester, and 17, Victoria Street, London, S.W., to make stainless iron and steel in open-hearth furnaces by their patented process. By this method the cost of production of all qualities of hard and soft stainless material is much reduced, and a great extension of their uses is predicted.

Archibald D. Dawnay & Sons, Limited, Steelworks Road, Battersea, S.W.11, have, as recently announced, purchased the extensive structural engineering works lately occupied by Sir William Arrol & Company (Swansea), Limited, at King's Dock, Swansea. The acquirement of these works, in addition to those already existing at Battersea, Welwyn Garden City, Cardiff and Norwich, will enable the company to very greatly increase their capacity for the rapid fabrication of all classes of constructional steelwork for buildings, etc. It is their intention to develop the Swansea Works on the most up-to-date lines, and particularly to pay attention to the export trade, the works being in close proximity to the extensive docks at Swansea with every facility for the transportation of material.

At the inaugural meeting of the Rotherham Technical and Engineering Society, held at the Technical Institute, Rotherham, on Friday evening, Mr. Francis C. Moss, A.M.I.M.E., the president, gave an interesting address. He said that some nine years had passed since the termination of the greatest war the world had ever known, and it would be interesting to make a brief survey of the present position in the steel and engineering industries; those basic industries so vital to the welfare of the nation. The Ministry of Labour published monthly figures showing present retail prices of all commodities compared with those existing in July, 1914, for the purpose of determining the cost of living. At the present time those figures were as follows:— Food, 59 per cent. increase; rent, 51 per cent.; fuel and lighting, 70 per cent.; men's clothing, boots, etc., 110 to 115 per cent.; a collection of all items making up the cost of living of an average working-class family worked out at 64 per cent. increase on the same quantities and qualities. In a similar manner the Board of Trade issued index figures to various industries, a few of which were as follows:—Iron and steel, 18 per cent. above July, 1913; coal, 23 per cent.; all the other commodities averaging 41 per cent. above July, 1913. These figures conclusively proved that the iron and steel industry led the field in price reduction to date. Lord Gainford, at the recent meeting, quoted very interesting figures relating to his company, Messrs. Pease & Partners, as follows:—Local rates, 1914, £45,000, 1927, £155,000; workmen's compensation, insurance and welfare, 1914, £41,000, 1927, £243,000. The total expense under these headings was three times as much as in 1914, and actually represented a cost of 5s. 1d. on each ton of pig-iron produced, compared with 1s. 4d. in May, 1913. Many examples had recently been published in the Iron and Coal Trades Review, all emphasising the heavy burdens coal and iron works had to bear in the shape of local rates. In the case of collieries the burden now represented a charge of sixpence or sevenpence per ton of coal output. He asked them to think what a burden rates alone meant when multiplied many times as it was before they got to the finished steel goods. One process only could be mentioned, that of "forging crank shafts," which was a rather intricate work, and the coal consumption was in the region of three tons per ton of forging output. Therefore the coal cost alone carried rates to the extent of some 1s. 6d. per ton of forging output quite additional to the many other items required in connection with the same work, which all bore a similar proportion of rates. So great were these burdens that the efficiency of industry was being imperilled and their competitive capacity ruined, as they were unable to meet these demands and at the same time make adequate allocations for depreciation, renewals and developments.

Personal.

Sir John Prestidge, a director of Messrs. J. Stone & Company, Limited, engineers and founders, of Deptford, has presented that town with a gold chain for the use of the Mayoress.

Mr. C. E. Lloyd, M.P. for Dudley, has left England for a four months' tour in Australia. Mr. Lloyd is a member of the directorate of M. Hingley & Sons, Limited, Netherton.

Mr. H. Harrison and Mr. F. W. Cooper have resigned from the board of the Pearson & Knowles Coal & Iron Company, Limited, and the directors have elected Mr. A. S. Macharg and Mr. J. P. Davison to fill the vacancies.

Mr. H. Hunter has been appointed general manager of the North-Eastern Marine Engineering Company, Limited, Wallsend, in consequence of the death of Mr. A. S. Wimble. Mr. J. S. Mackay becomes works manager, Mr. J. Tindale chief draughtsman, and Mr. W. Hoy manager of the superheating department.

Mr. Joseph Arrowsmith, on his retirement from the position of melting shop manager at the Earl of Dudley's Round Oak Iron and Steel Works, Brierley Hill, Staffs., has been the recipient of numerous presentations. He has been with the firm nearly forty years, and will still retain a connection with it in an advisory capacity.

Mr. H. Spurrier, the managing director of Leyland Motors, Limited, has just returned from a business trip round the world. His time while abroad has been principally occupied with the inspection of the company's very extensive overseas branches and sales and service organisation, particularly throughout Australia, New Zealand and Canada. Mr. Spurrier has returned with optimistic views as to the future of the British commercial vehicle industry's activities in our Dominions. Whilst the weight restrictions in Australia and New Zealand, Ceylon, India and elsewhere are at present some hindrance to the full development of the heavier types of commercial vehicle, Mr. Spurrier is convinced that there are innumerable other opportunities for the introduction of further commercial vehicles of various types in such parts of the world. It may be recalled that the Leyland Company has for a number of years had its own direct branches in India, Singapore, Melbourne, Sydney, Brisbane, Wellington, Auckland, Christchurch, Capetown, Toronto, Montreal, Winnipeg, Vancouver and Victoria, as well as established agencies in many countries of importance overseas.

Wills.

Fishwick, E. R., of 3, Eberle Street, Liverpool, and Wallasey, Cheshire, brass-founder and engineer £12,674

Levin, H., of Nether Street, North Finchley, N., and Sugar House Lane, Stratford E., metal merchant £16,479

Contracts Open.

Dublin, October 19.—460 tons of steelwork, for the Great Southern Railways (Ireland). Mr. J. F. Sides, Broadstone Station, Dublin. (Fee £2 2s., non-returnable.)

Hertford, October 17.—Materials, for the Corporation. The Borough Surveyor and Engineer, The Castle, Hertford.

London, S.E.1, October 19.—Crossings, etc., for the India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1: (1) Chrome steel crossings, switches and spare parts; (2) under-frames and ironwork for 90 goods brake vans. (Fee 5s. per set, non-returnable.)

Sheffield, October 10.—Lamp pillars, for the City Council. The Lighting Engineer, 42, Corporation Street, Sheffield.

Teignmouth, October 24.—Gas main, etc.; 14-in. diameter cast-iron gas main; water-tube condenser of 250,000 cubic feet per day capacity; rotary washer scrubber of 500,000 cubic feet per day capacity; station meter of 25,000 cubic feet per hour capacity; three-lift gasholder; Lancashire boiler, 26 ft. by 7 ft. diameter, 150-lb. pressure, for the Urban District Council. Mr. H. Higham, gas engineer and manager.

Obituary.

Mr. P. Duff, of J. Gordon Alison & Company, Limited, Birkenhead, died recently at the age of 77.

Mr. W. Walshaw, of Highfields, Doncaster Gate, Rotherham, whose death has occurred at the age of 47 years, was for many years a mill manager at the works of Steel, Peech & Tozer, Limited, Rotherham.

"SERVICE GRC FIRST"

To the Ironfounders of Scotland!

THE ROCK SAND of LOUDOUN

The "Blue Bells of Scotland"—famous the world over—never grow in sweeter profusion than in and on "Loudoun's Bonnie Woods and Braes" (sung wherever Scots do foregather) when their harbingers, the snowdrops, have melted from the green hollows.

In the dells around Loudoun Castle in Ayrshire they shimmer every springtime, a blue mist in the woods, to the joy of the early bee and the local youth of both sexes.

But the Loudoun lands enclose treasures which appeal to the practical mind of the Ironfounder of Scotland as powerfully as do the flowers to his sentimental side (and what Scottish Foundryman is devoid of either?).

For the justly celebrated "Loudoun Sand Rock" is found here, and here alone, and the Countess of Loudoun has concurred in an arrangement whereby the General Refractories Company, Ltd., of Sheffield, are quarrying the rock and preparing it for the Foundry in a plant which is the last word in "fool proof" efficiency, and erected within sight of that grey pile which could tell the bloody story of Scottish history, if stones had eyes and tongues.

In all Scotland there is no such plant so adequate, so certain in its action, so regular in its results, and, withal, so economical and inexpensive to operate.

The arrangement of the plant is the result of fourteen years' experience of Foundry Sand preparation by the General Refractories Co., Ltd., which probably supplies more Foundry Sand than any other producer in Great Britain, and the result is a sand of which its makers are proud.

They now offer it with confidence that it will enhance their reputation and be in accord with their freely stated principles of "Service First"—which, translated into practice, means that they desire only to deliver goods which will cause their recipients neither worry nor bother, but will, on the other hand, enable them to do their work more easily, more profitably, and more happily.

The Loudoun Rock Sand will do this. It is a soft, well-bonded, yellow sand, absolutely free from lumps, stones, or pieces of clay, and of such reliable regularity that it may be used very day in the week to form part of a mixture without the slightest need to alter the proportion of it which the mixture contains.

It is not so close and dense that venting between its pores is impossible, but it dries in the mould with a surface smooth enough to ensure a clean blue skin on the casting, strong enough not to be broken by a rush of metal, and refractory enough not to burn on or cause unsightly scabs, but, on the other hand, to fall off with a light tap.

There is here a rare combination of valuable qualities which explains the steady growth in its sales, and the constant repeat orders which are continually being received.

It will be a pleasure to the Company to receive applications for free sample bags, which will be sent carriage paid to any part of the country.

From resources also entirely on the lands of Loudoun there is being produced the "Loudoun Loam Sand," a dense, strongly bonded sand in great favour for many jobs.

This is just as reliable as the Rock Sand and is offered with the same confidence—samples of this also will be sent free, on application.

Many British Ironfounders are users of Scottish Rock Sands and are invited to make a free test of these two sands, produced under ideal conditions, of faultless quality, and at a price which compares favourably with any other on the market.

Glasgow: 58, York Street (A. W. MONTGOMERY). 'Phone: 1511 Central.

Iron and Steel Markets.

Pig-iron.

MIDDLESBROUGH.—The end of the quarter just completed finds the Cleveland iron trade in a much more satisfactory position than has been previously experienced so far this year, although, unfortunately, only about half the normal number of furnaces in blast on Tees-side are as yet in full operation. There is, moreover, a more confident feeling abroad that a steady expansion of business may develop at an early date, an assumption supported by the fact that consumers are less hesitant to place orders for forward delivery than has hitherto been the case, while export business is also steadily improving under the more favourable price conditions now obtaining. This impression is confirmed by the fact that the Tees shipments of pig-iron to foreign ports are on a better scale this month than in any previous month this year, and there is still a healthy volume of inquiry. Prices now appear to be firmly stabilised for the time being, at all events, quotations remaining unaltered and subject to the usual 2s. 6d. per ton discount on sales to Scotland or abroad:—No. 1 Cleveland foundry iron, 70s. per ton; No. 3 Cleveland G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. per ton.

Conditions in the Tees-side market for hematite, though not quite so promising in outlook as that for foundry iron, may still be regarded as slightly improved, demand just about absorbing current output. But there are indications of a better export inquiry. The nominal quotation for mixed numbers is 75s. per ton, and for No. 1 75s. 6d., f.o.t. or f.o.b., but, as before, these prices can be shaded. There is no change to report in the position on the North-West Coast, quotations remaining nominal around 75s. per ton for Bessemer mixed numbers.

LANCASHIRE.—The volume of business reported in local markets for foundry pig continues below average for the season, but a few buyers on forward account furnish hopes of a revival in trade as the autumn advances. The general quotation for Derbyshire No. 3 for delivery in the Manchester area is 73s. per ton. Staffordshire brands range from 73s. to 73s. 9d. Cleveland keeps steady at 80s. 8d., delivered Lancashire, with Scottish quoted at round 91s., and hematites at 87s., also delivered.

THE MIDLANDS.—At Birmingham last week it was the general experience of sellers of foundry iron that rather more orders are now being placed. It is not thought, however, that consumption is actually increasing, but buyers are operating a little further ahead, in view of their confidence that prices have probably touched bottom. Prices remain steady at previous levels. Northants No. 3 is offered at 60s. 6d., Derbyshire 65s., and North Staffordshire 65s. per ton, f.o.t. furnaces.

SCOTLAND.—Consumers of foundry pig in this area now recognise that prices are down to a level that might warrant buying under normal conditions, but the outlook is so uncertain and founders have so little work on their books that they have not the courage to go into the market and buy forward to any appreciable extent. Prices, however, are steadily maintained, the current quotation ruling at 73s. 6d. for No. 3 foundry at furnaces.

Finished Iron.

Business, as far as the finishing branches of the industry are concerned, remains at a very limited level, makers insisting that pig-iron prices must go lower still to enable them to take the ruling prices for bar iron. Prices are unchanged at £9 10s. per ton for crown bars in the usual specifications, but competition is keen to secure any lines that offer. For the genuine South Staffordshire crown iron, however, the price is nearer £10 10s., and certainly not less than £10 5s. Foreign competition for nut and bolt iron is keener than ever, and South Staffordshire makers are getting but small share of the business at about £9 per ton delivered this district, against the foreign price of £5 15s. per ton. Marked bars remain at £13 10s. per ton at makers' works. There is a slight improvement in the consumption, but bulk orders are lacking.

Steel.

Notwithstanding the highly optimistic predictions of a certain section of the Press, the steel industry in most branches continues only partially active, while there is sharp competition for business in billets, both basic and acid, but buying of the former does not appear to have been stimulated to any extent by the recent modification of prices. Siemens acid billets are slowly bought at £10 per ton delivered, and basic billet figures are:—Soft, £7; semi-hard, £7 10s.; medium, £7 12s. 6d.; hard, £8 2s. 6d. per ton delivered. There has been a further limitation of the output of open-hearth steel in the district, but the total production still makes an impressive figure. Crucible steel production is tapering off, and some of the electric steel furnaces are out of operation. Makers of high-speed and special steels are fairly well employed. There is no improvement in the condition of the tinplate market, which continues very quiet. The demand is weak and the volume of business done has been limited. The competition for orders is keen and many mills are idle.

Scrap.

Demand for most descriptions of foundry scrap material continues slow in the various markets, and even the reduction in pig-iron prices has had no perceptible effect upon the general outlook. In the Midlands, however, there is a fairly good inquiry for heavy cast-iron scrap in cupola sizes. For the heavier qualities 70s. to 73s. per ton delivered is offered. The lighter qualities are weaker at 55s. to 58s. per ton delivered. Cast-iron borings are firm at 30s. per ton f.o.t. In Scotland machinery cast-iron scrap remains unchanged, and it is difficult to find buyers even at 68s. 6d. to 69s. per ton, for material suitable for foundries and in pieces not exceeding 1 cwt. Heavy ordinary cast-iron scrap to the same specification is down to 63s. to 64s. per ton. Old cast-iron railway chairs are being offered at 68s. 6d. to 70s., with few buyers. Old cast-iron scrap and firebars are unchanged around 57s. 6d. per ton. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—An outstanding feature of the daily reports of the market for base metals of late has been the remarkable steadiness of standard copper, which, in comparison with other sections, has fluctuated only to a fractional extent during the past few weeks. This has been mainly due to a distinctly more active demand on either side of the Atlantic, following the publication of the American statistics, showing heavy tonnages having been placed by the combine for shipment to European ports within the next few months. Confidence, at any rate, had been strengthened to a degree which might easily have enabled the larger American producers to advance their terms to some extent.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £53 11s. 3d. to £53 12s. 6d.; Friday, £53 7s. 6d. to £53 8s. 9d.; Monday, £53 18s. 9d. to £54; Tuesday, £53 18s. 9d. to £54; Wednesday, £54 to £54 16s.

Three Months: Thursday, £54 to £54 1s. 3d.; Friday, £53 15s. to £53 16s. 3d.; Monday, £54 5s. to £54 6s. 3d.; Tuesday, £54 5s. to £54 6s. 3d.; Wednesday, £54 6s. 9d. to £54 7s. 6d.

Tin.—A further droop in cash values of tin developed last week, and, although in view of the recent rapid decline a rally would appear to be due, it is difficult to see any genuine reason why such a recovery should be maintained for long. Business with America has been small. Consumers there are reported to be well covered until the end of October, and fairly well until the end of December.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £266 5s. to £266 10s.; Friday, £265 to £265 5s.; Monday, £267 5s. to £267 10s.; Tuesday, £269 5s. to £269s. 10s.; Wednesday, £267 5s. to £267 10s.

Three Months: Thursday, £264 15s. to £265; Friday, £262 to £262 5s.; Monday, £264 10s. to £264 15s.; Tuesday, £266 15s. to £267; Wednesday, £263 12s. 6d. to £263 17s. 6d.

Spelter.—A slight improvement in the outlook for ordinary spelter may at length be noted, consequent upon better buying for near delivery by consumers, and more favourable American advices. Continental offers were not being pressed on the market, but there is a full European production to be reckoned with. Galvanisers appear rather pessimistic as to the immediate prospects of their industry.

The following are the week's prices:—

Ordinary: Thursday, £27 7s. 6d.; Friday, £26 17s. 6d.; Monday, £26 12s. 6d.; Tuesday, £26 12s. 6d.; Wednesday, £26 8s. 9d.

Lead.—In the market for soft foreign pig during the past week values have not lost much on balance, while at times there was fairly active buying by consumers, and repurchases by dealers induced by firm American advices, disclosing a decrease in the refinery stocks. It is expected that some of the Broken Hill mines have been shut down, and mining restrictions in other directions may strengthen the market further, although excessive stocks are still weighing on the market.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £20 12s. 6d.; Friday, £20 2s. 6d. Monday, £20 6s. 3d.; Tuesday, £20 6s. 3d.; Wednesday, £20 5s.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Re Rammed Linings for Cupola.

To the Editor of The Foundry Trade Journal.

Sir,—Referring to the above article in your Journal dated September 22, I am very interested in the data given, but would be pleased to know whether a peg or flat rammer is recommended? Also, how hot should the rammers be made in order to give the best results?—Yours, etc.,

D. L. Grant.

Scottsdale, St. Albans.
September 28, 1927.

To the Editor of The Foundry Trade Journal.

Sir,—I have noted with interest the article in the last issue of The Foundry Trade Journal under "Rammed Linings for Cupolas." I should esteem it a favour if you would be good enough to recommend a suitable gannister for this work, and at the same time to let me have your candid opinion as regards the comparison between this and a brick lining.—Yours, etc.,

E. A. Phillips,
Director.

Harper, Phillips & Company, Limited,
Albion Foundry,
Eastgate, Grimsby.

Spun-Sorbitic Castings.

To the Editor of The Foundry Trade Journal.

Sir,—"Marksman's" comments in his Random Shots in your issue dated September 22 have come before the writer's notice. I am extremely glad that "Marksman" recognised the metallurgical character of the descriptive title which we have adopted for our new cast iron.

Some engineers have suggested that our title has reference to rubber sponges, whilst another, who is obviously well up in medical terminology, examined our castings carefully for scorbutic tendencies. We should like to assure all engineers that Spun-Sorbitic castings are cast by the centrifugal process and are consequently free from any of the properties associated with any brand of rubber sponges, nor have they any scorbutic tendencies.

"Marksman" is perfectly right, and the title "Sorbitic" is a metallurgical term, and refers to the constitutional character of the material. The properties of material of this constitutional character have been definitely established in connection with steel, and the discovery of the method of obtaining these properties in cast iron is worthy of special identification by a special title. In this respect I should like to emphasise that the deliberate production of cast iron in a sorbitic pearlite condition is definitely novel and has not been practical before. From this point of view, the material produced by this process has a clear right to a distinguishing metallurgical title.

There is a broader aspect which arises out of "Marksman's Random Shot." The retention of the metallurgical terms descriptive of the constitutional character of iron-carbon alloys, tends to much obscurity of thought, which to my mind is hardly counterbalanced by the historical value of these terms.

I, personally, should be glad to see the adoption, by general consent, of the same system of nomenclature to the iron-carbon system as is adopted in the case of all other alloy systems. In this connection I heartily approve of the adoption of this uniform system to the iron-carbon alloys by Dr. Hanson in his recent important Paper.

Sheffield. Yours, etc.,
Oct. 4. J. E. Hurst.

Sterling

BOXES

STAND UP TO THEIR WORK BECAUSE THEY ARE MADE FROM

ROLLED STEEL

THEY ARE LIGHT AND EASY TO HANDLE, STRONG, RIGID AND PERMANENTLY ACCURATE.

There is no greater economy you can introduce into your foundry than the

Sterling Rolled Steel Moulding Box

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STERLING FOUNDRY SPECIALTIES LTD., BEDFORD

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WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	54 0 0
Three months	54 6 9
Electrolytic	61 15 0
Tough	59 10 0
Best selected	60 10 0
Sheets	86 0 0
India	71 0 0
Wire bars	62 5 0
Do. October	62 5 0
Do. November	62 5 0
Ingot bars	62 5 0
H.C. Wire rods	66 15 0
Off. av. cash, Sept.	54 9 9 3/11
Do. 3 mths., Sept.	54 19 0 3/11
Do., Sttlmnt., Sept.	54 9 9 3/11
Do., Electro, Sept.	62 0 2 3/11
Do., B.S., Sept.	60 11 11½
Aver. spot price, copper, Sept.	54 9 9½
Do., Wire bars, Sept.	62 3 10½
Solid drawn tubes	12½d.
Brazed tubes	12½d.
Wire	9½d.

BRASS.

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	10⅝d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	9¾d.
Wire	9¾d.
Rolled metal	9¾d.
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

	£ s. d.
Standard cash	267 5 0
Three months	263 12 6
English	266 5 0
Bars	270 10 0
Straits	275 10 0
Australian	274 10 0
Eastern	271 5 0
Banca	279 10 0
Off. av. cash, Sept.	280 10 10 5/11
Do., 3 mths., Sept.	276 6 2 5/11
Do., Sttlmt., Sept.	280 10 5 5/11
Aver. spot, Sept.	280 10 10¼

SPELTER.

	£ s. d.
Ordinary	26 8 9
Remelted	24 15 0
Hard	21 0 0
Electro 99.9	30 5 0
English	27 0 0
India	23 0 0
Zinc dust	36 0 0
Zinc ashes	8 15 0
Off. aver., Sept.	27 6 8 3/5
Aver., spot, Sept.	27 6 11¼

LEAD.

	£ s. d.
Soft foreign ppt.	20 5 0
English	21 15 0
Off. average, Sept.	21 14 4 3/4
Average spot, Sept.	21 8 11

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	36 0 0
Do. V.M. ex whf.	34 10 0
Rods	42 0 0
Boiler plates	34 0 0
Battery plates	33 10 0

ANTIMONY.

	£ s. d.
Special brands, Eng.	64 10 0
Chinese	45 0 0
Crude	38 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	21 15 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%..	8 17 6
45/50%	12 15 6
75%..	20 5 0
Ferro-vanadium—	
35/40%	14/3 lb. va.
Ferro-molybdenum—	
70/75% c. free	5/- lb.
Ferro-titanium—	
23/25% carbonless	11½d.
Ferro-phosphorus, 20/25%	£17 15 0
Ferro-tungsten—	
80/85%, c. fr.	1/3 lb.
Tungsten metal powder—	
98/99%	1/8½ lb.
Ferro-chrome—	
2/4% car.	£33 0 0
4/6% car.	£23 0 0
6/8% car.	£22 17 6
8/10% car.	£22 10 0
Ferro-chrome—	
Max. 2% car.	£36 0 0
Max. 1% car	£41 10 0
Max. 0.70% car	£53 0 0
70%, carbonless	1/4½ lb.
Nickel—99%, cubes or pellets	£170 0 0
Ferro-cobalt	9/3 lb.
Aluminium 98/99%	£105 0 0
Metallic chromium—	
96/98%	3/- lb.
Ferro-manganese (net)—	
76/80%, loose	£13 0 0
76/80%, packed	£14 0 0
76/80%, export	£11 15 0
Metallic manganese—	
94/96%, carbonless	1/10 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 6
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/-lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.
South Wales—	
Hvy. steel	2 17 6
Bundled steel and shrngs.	2 10 0 to 2 12 6
Mixed iron and steel	2 10 0 to 2 12 6
Heavy cast iron	2 17 6
Good machinery for foundries	3 0 0
Cleveland—	
Heavy steel	2 15 0
Steel turnings	2 5 0
Cast iron borings	2 2 6
Heavy forge	3 12 6
Bushelled scrap	3 2 6
Cast-iron scrap	3 1 0 to 3 5 0
Lancashire—	
Cast-iron scrap	3 5 0
Hvy. wrought	3 2 6
Steel turnings	2 2 6

London—Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean)	48 0 0
Brass (clean)	37 0 0
Lead (less usual draft)	18 10 0
Tea lead	16 0 0
Zinc	16 10 0
New aluminium cuttings	76 0 0
Braziery copper	45 0 0
Gunmetal	46 0 0
Hollow pewter	170 0 0
Shaped black pewter	130 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	75/6
Hematite M/Nos.	75/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	83/6
,, d/d Birm.	92/6
Midlands—	
Staffs. common*	—
,, No. 4 forge	60/-
,, No. 3 fdry.	65/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	54/-
,, fdry. No. 3	60/6
Derbyshire forge	60/-
,, fdry. No. 3	65/-
,, basic	—
Scotland—	
Foundry No. 1	—
,, No. 3	73/6
Hem. M/Nos.	76/-
Sheffield (d/d district)—	
Derby forge	66/-
,, fdry. No. 3	68/-
Lincs. forge	—
,, fdry. No. 3	68/-
E.C. hematite	85/-
W.C. hematite	90/6
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	73/-
Northants foundry No. 3	—
Dalzell, No. 3	105/- to 107/6
Summerlee, No. 3	91/- to 100/-
Glengarnock, No. 3	91/- to 100/-
Gartsherrie, No. 3	91/- to 100/-
Monkland, No. 3	91/- to 100/-
Coltness, No. 3	91/- to 100/-
Shotts, No. 3	91/- to 100/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.	9 15 0	to 10 15 0
Angles	—	
Tees to 3 united ins.	—	
Nut and bolt iron	—	
Hoops	14 10 0	
Marked bars (Staffs.) f.o.t.	13 10 0	
Gas strip	12 10 0	
Bolts and nuts, ¾ in. × 4 in.	15 5 0	
Steel—		
Ship plates	8 2 6	
Boiler plts.	10 10 0	
Chequer plts.	10 5 0	
Angles	7 12 6	
Tees	8 12 6	
Joists	7 12 6	
Rounds and squares, 3 in. to 5½ in.	7 15 0	
Rounds under 3 in. to ⅜ in. (Untested)	8 0 0	and upwards
Flats, over 5 in. wide and up	9 2 6	
Flats, 5 in. to 1½ in.	8 2 6	
Rails, heavy	8 2 6	
Fishplates	12 10 0	
Hoops (Staffs.)	10 10 0	
Black sheets, 24g.	10 7 6	
Galv. cor. shts., 24g.	13 17 6	
Galv. fencing wire 8g. plain	12 10 0	
Billets, soft	£6 0 0	to 7 0 0
Billets, hard	8 2 6	
Sheet bars	£5 12 6	to 5 15 0
Tin bars	£5 12 6	to 5 15 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1 2½
Sheet to 10 w.g.	1 2¾
Wire	1 3½
Rods	1 2¾
Tubes	1 8
Castings	1 2

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9¼
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	20.26
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	17.25
Basic	20.00
Bessemer	19.76
Malleable	19.26
Grey forge	18.76
Ferro-mang. 80% d/d	90.00
Bess rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	34.00
Wire rods	43.00
	Cents.
Iron bars, Phila.	2.07
Steel bars	1.75
Tank plates	1.75
Beams, etc.	1.75
Skelp, grooved steel	1.75
Skelp, sheared steel	1.75
Steel hoops	2.30
Sheets, black, No. 24	3.00
Sheets, galv., No. 24	3.85
Sheets, blue an'l'd., 9 and 10	2.25
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.25
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	—
,, furnace	14/-
Other Districts, foundry	—
,, ,, furnace (basis)	12/-

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14	box	18/3
,,	28×20	,,	36/6
,,	20×10	,,	—
,,	18¾×14	,,	—
C.W.	20×14	,,	17/3
,,	28×20	,,	—
,,	20×10	,,	—
,,	18¾×14	,,	—
Terneplates	28×20	—	per box basis f.o.b.

SWEDISH IRON.

Bars, hammered,	£18 10 0 to 19 0 0
Rolled Ord.	£15 0 0 to £15 10 0
Nail rods	£15 7 6 to £15 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£5 15 0 to £6 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	45%
Water	63½%	40%
Steam	60%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£ s. d.	
Sept. 29	53 11 3	dec. 8/9
,, 30	53 7 6	,, 3/9
Oct. 3	53 18 9	inc. 11/3
,, 4	53 18 9	No change
,, 5	54 0 0	inc. 1/3

Electrolytic Copper.

	£ s. d.	
Sept. 29	61 0 0	dec. 10/–
,, 30	61 0 0	No change
Oct. 3	61 15 0	inc. 15/–
,, 4	61 15 0	No change
,, 5	61 15 0	,,

Standard Tin (Cash).

	£ s. d.	
Sept. 29	266 5 0	inc. 65/–
,, 30	265 0 0	dec. 25/–
Oct. 3	267 5 0	inc. 45/–
,, 4	269 5 0	,, 40/–
,, 5	267 5 0	dec. 40/–

Tin (English ingots).

	£ s. d.	
Sept. 29	265 10 0	inc. 60/–
,, 30	264 0 0	dec. 30/–
Oct. 3	266 10 0	inc. 50/–
,, 4	268 10 0	,, 40/–
,, 5	266 5 0	dec. 45/–

Zinc Sheets (English).

	£ s. d.	
Sept. 29	36 0 0	No change
,, 30	36 0 0	,, ,,
Oct. 3	36 0 0	,, ,,
,, 4	36 0 0	,, ,,
,, 5	36 0 0	,, ,,

Spelter (ordinary).

	£ s. d.	
Sept. 29	27 7 6	dec. 1/3
,, 30	26 17 6	,, 10/–
Oct. 3	26 12 6	,, 5/–
,, 4	26 12 6	No change
,, 5	26 8 9	dec. 3/9

Lead (English).

	£ s. d.	
Sept. 29	22 0 0	No change
,, 30	21 15 0	dec. 5/–
Oct. 3	21 15 0	No change
,, 4	21 15 0	,,
,, 5	21 15 0	,,

AVERAGE MONTHLY PRICES OF RUBIO ORE (MIDDLESBROUGH).

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly Average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1890	0 15 4	0 15 4	0 15 4	0 15 4	0 15 4	0 15 4	0 15 4	0 14 3	0 14 3	0 15 7½	0 15 7½	0 15 7½	0 15 2¾
1891	0 15 7½	0 14 2½	0 14 2½	0 14 2½	0 13 6¾	0 13 6	0 13 3¾	0 13 0	0 12 11	0 13 0	0 13 7	0 13 1	0 14 9½
1892	0 13 1	0 12 9	0 12 9	0 12 9	0 12 9	0 11 10½	0 12 1	0 12 1	0 12 2	0 12 0	0 12 0	0 11 11	0 12 4¼
1893	0 11 11	0 11 5½	0 11 10	0 11 10	0 12 1¼	0 12 3	0 12 1½	0 12 3	0 12 1	0 12 4	0 12 4½	0 12 6	0 12 0¾
1894	0 12 6	0 12 6	0 12 7½	0 12 1¾	0 12 4	0 12 1	0 12 3	0 12 4	0 12 4	0 12 6	0 12 7	0 12 6	0 12 2¼
1895	0 12 0	0 12 0	0 11 10	0 12 0	0 12 0	0 12 3	0 12 3	0 12 9	0 12 9	0 13 6	0 15 0	0 14 9	0 13 1
1896	0 12 6	0 12 6	0 12 9	0 12 9	0 12 9	0 12 7	0 12 9	0 14 0	0 14 0	0 15 0	0 14 3	0 15 3	0 14 8
1897	0 15 3	0 15 6	0 15 3	0 15 0	0 14 0	0 14 3	0 14 3	0 14 0	0 14 0	0 14 9	0 15 0	0 14 9	0 14 7
1898	0 15 0	0 14 4	0 14 9	0 14 6	0 15 0	0 15 0	0 14 0	0 14 0	0 14 0	0 14 9	0 15 0	0 14 9	0 14 7
1899	0 15 0	0 15 3	0 15 6	0 15 6	0 15 9	0 16 0	0 17 6	0 18 0	0 17 9	0 18 0	0 19 0	1 0 0	0 16 11½
1900	1 1 0	1 0 6	1 1 0	1 0 9	1 1 0	1 1 0	1 1 3	1 1 6	1 1 3	1 1 3	1 0 0	0 18 0	1 0 8½
1901	0 17 6	0 16 0	0 15 0	0 14 6	0 15 6	0 15 9	0 14 9	0 15 3	0 15 9	0 15 9	0 15 9	0 15 9	0 15 7½
1902	0 15 6	0 15 0	0 16 0	0 16 0	0 15 6	0 15 3	0 15 6	0 16 0	0 16 0	0 16 0	0 15 9	0 15 6	0 15 8½
1903	0 15 6	0 16 0	0 16 6	0 16 3	0 16 3	0 16 10	0 15 9	0 15 6	0 15 6	0 14 9	0 14 9	0 15 1	0 15 8
1904	0 14 9	0 15 3	0 15 1	0 15 4	0 15 3	0 15 0	0 14 5	0 14 6	0 14 6	0 14 6	0 14 6	0 14 7	0 14 9½
1905	0 15 3	0 15 6	0 15 0	0 15 3	0 15 6	0 15 6	0 15 6	0 15 6	0 16 6	0 18 6	0 18 9	0 18 9	0 16 3½
1906	1 0 0	1 1 6	1 0 0	1 0 0	0 19 6	1 0 0	0 19 6	0 19 4	1 0 6	1 1 6	1 1 9	1 3 6	1 0 7
1907	1 3 6	1 2 6	1 2 6	1 2 0	1 1 6	1 2 3	1 2 3	1 2 0	1 1 0	0 19 0	0 18 9	0 17 6	1 1 2½
1908	0 16 6	0 15 0	0 15 6	0 15 6	0 15 3	0 15 0	0 15 0	0 14 9	0 15 0	0 16 0	0 16 0	0 16 0	0 15 5½
1909	0 15 9	0 16 3	0 16 0	0 16 0	0 16 3	0 16 6	0 16 0	0 16 0	0 17 0	0 17 0	0 17 6	0 17 6	0 16 6
1910	1 0 4	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 9	1 0 3	1 0 3	1 0 6¾	1 1 3	1 1 5	1 0 9¾
1911	1 2 2¾	1 2 6	1 2 6	1 1 11½	1 0 11½	0 19 6	0 19 0	0 19 0	0 19 1¾	0 19 6	1 0 0¾	1 1 6¾	1 0 7½
1912	1 2 3	1 2 6	1 2 6	1 1 1¾	1 1 6	1 1 6	1 1 6	1 2 3	1 2 6	1 3 0	1 3 0	1 2 11	1 2 2½
1913	1 2 9	1 2 2	1 1 7½	1 1 6	1 0 8½	1 0 0	1 0 0	1 0 0	0 19 10½	0 19 1½	0 19 0	0 19 0	1 0 5½
1914	0 18 7½	0 18 0	0 18 0	0 17 9	0 17 6	0 17 6	0 17 1½	0 19 7½	0 18 11½	0 17 10½	0 18 7½	1 1 0½	0 18 5½
1915	1 7 7½	1 8 6	1 9 3	1 10 2½	1 8 6	1 6 4	1 5 10½	1 6 0	1 6 10½	1 10 8½	1 13 0	1 17 10	1 9 1½
1916	1 18 6	2 0 1½	2 2 6½	2 0 6½	1 15 0	1 16 3	1 18 0	1 18 0	1 18 0	—	—	—	—
1917	Price Fixed												
1918													
1919	—	—	—	—	2 5 7½	2 14 4½	2 16 4½	2 14 0	2 13 4½	2 13 0	2 12 7½	2 11 9	—
1920	2 17 0	3 7 9	2 15 6	3 6 7	3 0 0	2 15 0	2 14 0	2 9 9	2 7 6	2 11 0	2 12 3	2 10 0	2 15 0
1921	2 1 0	2 0 1½	1 18 3	1 17 6	1 17 6	1 17 6	1 17 6	1 5 0	1 8 9½	1 7 9	1 7 0	1 7 0	1 13 8½
1922	1 6 7½	1 5 10½	1 6 11	1 7 0	1 7 0	1 7 0	1 5 3	1 4 9½	1 4 2½	1 3 3½	1 2 6	1 2 3	1 5 2½
1923	1 2 9½	1 4 6½	1 5 2	1 4 8½	1 4 6	1 4 0	1 3 6	1 3 0	1 3 0	1 3 2½	1 3 2½	1 4 9	1 3 10½
1924	1 4 2½	1 4 0	1 4 0	1 3 7½	1 3 8½	1 3 6	1 2 11	1 2 6	1 2 1½	1 1 7½	1 2 3	1 2 6	1 3 1
1925	1 2 6	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 6	1 0 6	1 0 0	1 0 0	1 0 3	1 0 10½	1 1 1½	1 1 4½
1926	1 1 1½	1 1 6	1 1 6	1 1 3½	1 1 3	1 1 5½	1 1 6	1 1 6*	1 1 0*	1 1 6*	1 1 6*	*	—
1927	1 2 1½	1 2 3	1 2 1½	1 2 0	1 2 0	1 2 0	1 1 7½	1 1 0	1 1 0	—	—	—	—

* Prices nominal.

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
ROYAL BLDS., FISHER ST., SWANSEA.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
20, SECOND LINE BEACH, MADRAS.
1, HONG KONG ROAD, SHANGHAI.

REGISTERED TRADE MARK

OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR.
5, SHAFFRAZ ROAD, RANGOON
NADIR HOUSE, MACLEOD ROAD, KARACHI.
1 SHAREH SONK EL TEWFIKIEH, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.